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Masahiro Ishino

Masahiro ISHINO

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Applicant(s): Matsushita Electric Works, Ltd.

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Inventor(s):

Address: c/o Matsushita Electric Works, Ltd.
1048, Oaza-Kadoma, Kadoma-shi, OSAKA
NAME: Takuma HASHIMOTO

Address: c/o Matsushita Electric Works, Ltd.
1048, Oaza-Kadoma, Kadoma-shi, OSAKA
NAME: Masaru SUGIMOTO

Address: c/o Matsushita Electric Works, Ltd.
1048, Oaza-Kadoma, Kadoma-shi, OSAKA
NAME: Ryoji YOKOTANI

Address: c/o Matsushita Electric Works, Ltd.
1048, Oaza-Kadoma, Kadoma-shi, OSAKA
NAME: Koji NISHIOKA

Address: c/o Matsushita Electric Works, Ltd.
1048, Oaza-Kadoma, Kadoma-shi, OSAKA
NAME: Yutaka IWAHORI

Address: c/o Matsushita Electric Works, Ltd.
1048, Oaza-Kadoma, Kadoma-shi, OSAKA
NAME: Shinya ISHIZAKI

Address: c/o Matsushita Electric Works, Ltd.
1048, Oaza-Kadoma, Kadoma-shi, OSAKA
NAME: Toshiyuki SUZUKI

Address: c/o Matsushita Electric Works, Ltd.
1048, Oaza-Kadoma, Kadoma-shi, OSAKA
NAME: Yoshiyuki UCHINONO

Address: c/o Matsushita Electric Works, Ltd.
1048, Oaza-Kadoma, Kadoma-shi, OSAKA
NAME: Masahide MUTO

Address: c/o Matsushita Electric Works, Ltd.
1048, Oaza-Kadoma, Kadoma-shi, OSAKA
NAME: Satoshi MORI

Applicant(s):

Identification No.: 000005832
Name: Matsushita Electric Works, Ltd.

Patent Attorney:

Identification No.: 100084375
Patent Attorney:
Name: Yasuo ITAYA

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CLAIMS

1. A light-emitting device comprising:

a submount comprising a mount base having metallization lines, and at least one light-emitting diode chip mounted thereon, and a circuit board comprising a metallic plate and an electrical connection pattern layer with electrically conducting lines formed on an insulator layer, said submount being mounted on said circuit board;

wherein electrically conducting lines formed on said submount are connected electrically to the electrically conducting lines of said circuit board, and the mount base makes thermal contact with the metallic plate in a portion wherein the pattern layer is exposed.

2. The light-emitting device according to claim 1, wherein at least one of said mount base and said circuit board has a protrusion having a plane to bond thermally to the other of said mount base and said circuit board.

3. The light-emitting device according to claim 1, wherein one of said mount base and said circuit board for heat transfer has a protrusion while the other has a recess, so that the protrusion fits into the recess to bond thermally between them.

4. The light-emitting device according to claim 2, wherein the light-emitting diode chip is mounted face down to said mount base with a bonding material (flip chip), and the bonding material makes thermal contact with the metallic plate via throughholes provided in the mount base.

5. The light-emitting device according to claim 4, wherein said throughholes are filled with a material having a higher thermal conductivity than the mount base.

6. The light-emitting device according to claim 1, further comprising a metallic member provided between said mount base and said circuit board for heat transfer.

7. The light-emitting device according to claim 1, wherein said mount base is made of a ceramic material.

8. The light-emitting device according to claim 1, wherein at least one groove is provided on the first plane of said mount base.

9. The light-emitting device according to claim 8, wherein each of said at least one groove comprises a bottom and two sides in a section, a width between the two sides increasing in a direction from the bottom toward an opening of said each of said at least one

groove.

10. The light-emitting device according to claim 8, further comprising a layer formed on said at least one groove made of a material having a thermal conductivity higher than said mount base.

11. The light-emitting device according to claim 8, wherein the light-emitting diode chip is mounted face down to the mount base with a bonding material (flip chip), and said at least one groove is formed between the bonding material and the first plane of the mount base to bond thermally to the exposed portion of the metallic plate.

12. The light-emitting device according to claim 8, wherein a number of said at least one groove is equal to or larger than two, and density of the grooves increases toward a region just below the light-emitting diode chip.

13. The light-emitting device according to claim 8, wherein a number of said at least one groove is equal to or larger than two, the grooves have different depths, and depth of the grooves increases toward a region just below the light-emitting diode chip.

14. The light-emitting device according to claim 8, wherein a number of said at least one groove is equal to or larger than two, the grooves have different depths, , the LED chips are mounted face-down on the mount base (flip chip), and depth of the grooves increases toward a region just below the bonding material.

15. The light-emitting device according to claim 8, wherein a number of said at least one groove is equal to or larger than two, the LED chips are mounted face-down on the mount base (flip chip), and density of the grooves increases toward a region just below the bonding material.

16. The light-emitting device according to claim 8, wherein a number of said at least one light-emitting diode chip is equal to or larger than two, a number of said at least one groove is equal to or larger than two, and density of the grooves increases toward a region just below a central light-emitting diode chip in the light-emitting diode chips.

17. The light-emitting device according to claim 8, wherein a number of said at least one light-emitting diode chip is equal to or larger than two, a number of said at least one groove is equal to or larger than two, the grooves have different depths, and said grooves have deeper depth in a region between a central light-emitting chip among the at least one light-emitting diode chip and the exposed portion of the metallic plate than in the other regions.

DESCRIPTION

Title of the Invention LIGHT-EMITTING DEVICE

Detailed Explanation of the Invention

Technical Field

[0001] The invention relates to a light-emitting device having a light-emitting diode (LED) chip, and in particular to a light-emitting device having good heat transfer.

Background Art

[0002] Recently, by combining a light-emitting diode (LED) chip for radiating blue or ultraviolet rays based on a gallium nitride semiconductor with a fluorescent material of various types, a light-emitting device which emits a light of a color or colors, including white, different from that of the emitting light of the LED chip has been developed. The light-emitting device has advantages such as small size, light weight and low dissipating power, and it is used widely for a light source for display, a light source in substitution of a small electric bulb, a light source for a liquid crystal display, and the like. When such a light-emitting device is used for a light source for display, a light source for liquid crystal panel or the like, the brightness per chip is low and insufficient. Then an LED package is provided to have an LED chip mounted and sealed on a mount base having electrically conducting portions to be connected to an external circuit, and a required number of LED packages are generally mounted on a print circuit board.

[0003] In order to provide a high light intensity, an injection current for an LED chip may be increased. Because an LED chip available now has efficiency as small as 10 %, a large part of input electric energy is converted to heat, so that the amount of heat increases with increasing current. It is known that characteristics such as life and efficiency of LED chip are deteriorated when the temperature rises due to the generated heat. Because the print circuit board for mounting the LED package is generally made of a resin such as polyimide or epoxy resin having low thermal conductivity, the generated heat cannot be radiated efficiently from the LED package.

[0004] Fig. 1 shows an example of a prior art light-emitting device 99 which efficiently transfers the heat generated in LED packages (for example, JP-A 2002-162626). Each of

the LED packages 90 having a pair of external terminals 95 of so-called plane mount type is mounted on a film base 92 which is a print circuit board made of polyimide. Lands 93 of electrically conducting patterns are formed on a top plane of the film base 92, while the back plane thereof is bonded with an adhesive to a supporting frame 91 made of a metal. The electrodes 95 of the LED packages 90 are connected to the lands 93.

[0005] Further, holes are formed vertically through the film base 92 and the frame 91 at regions below the LED packages 90, and an adhesive filler 94 having high thermal conductivity is filled into the holes to the back of the LED packages 90. A part of the heat generated by the LED chips conducts via the lands 93 to the film base 92 and further to the frame 91 to be radiated therefrom. Further, a large part of the heat generated in the LED package conducts directly through the adhesive filler to the film base 92 and further to the frame 91 to be radiated therefrom.

[Patent Document 1] JP-A 2002-162,626

Disclosure of Invention

Problem to be Solved by the Invention

[0006] However, the above-mentioned heat transfer structure of the light emitting device shown in Fig. 44 and in JP-A 2002-162626 has following problems. The adhesive filler made mainly of silicone resin and having high thermal conductivity is used to conduct the heat generated in the LED chip, but it has a smaller thermal conductivity than a material such as a metal or a ceramic. Further, at least a step for filling the filler into the holes for forming heat transfer paths is needed in a packaging process thereof, besides a step for mounting the LED packages 90 to the lands 93. Further, it is a problem that the filling step is troublesome.

[0007] An object of the invention is to provide a light-emitting device with an LED chip having a simple structure to improve heat transfer.

[Means for Solving the Problem]

[0008] In order to solve the problem, a light-emitting device of claim 1 comprises a submount comprising a mount base, at least one light-emitting diode chip mounted thereon, a metallic plate and an electrical connection pattern layer with electrically conducting lines formed on the mount base, wherein the mount base is mounted to the an electrical connection pattern layer, wherein the electrically conducting lines of the submount are

connected electrically to the electrical connection pattern layer of the circuit board, and the mount base makes thermal contact with the metallic plate in a portion wherein the pattern layer is exposed.

[0009] In the light-emitting device of claim 2 according to claim 1, at least one of the mount base and the circuit board for heat transfer has a protrusion having a plane to bond thermally to the other of the mount base and the circuit board.

[0010] In the light-emitting device of claim 3 according to claim 1, one of the mount base and the circuit board for heat transfer has a protrusion while the other has a recess, so that the protrusion fits into the recess to bond thermally between them.

[0011] In the light-emitting device of claim 4 according to claim 2, the light-emitting diode chip is mounted face down to the mount base with a bonding material, and the bonding material makes thermal contact with the metallic plate via throughholes provided in the mount base.

[0012] In the light-emitting device of claim 5 according to claim 4, the throughholes are filled with a material having a higher thermal conductivity than the mount base.

[0013] The light-emitting device of claim 6 according to claim 1 further comprises a metallic member provided between the mount base and the circuit board for heat transfer.

[0014] In the light-emitting device of claim 7 according to claim 1, the mount base is made of a ceramic material.

[0015] In the light-emitting device of claim 8 according to claim 1, at least one groove is provided on the first plane of the mount base.

[0016] In the light-emitting device of claim 9 according to claim 8, each of the at least one groove comprises a bottom and two sides in a section, a width between the two sides increasing in a direction from the bottom toward an opening of the each of the at least one groove.

[0017] The light-emitting device of claim 10 according to claim 8 further comprises a layer formed on the at least one groove made of a material having a thermal conductivity higher than the mount base.

[0018] In the light-emitting device of claim 11 according to claim 8, the light-emitting diode chip is mounted face down to the mount base with a bonding material, and the at least one groove is formed between the bonding material and the first plane of the mount base to bond thermally to the exposed portion of the metallic plate.

[0019] In the light-emitting device of claim 12 according to claim 8, a number of the at least one groove is equal to or larger than two, and density of the grooves increases toward a region just below the light-emitting diode chip.

[0020] In the light-emitting device of claim 13 according to claim 8, a number of the at least one groove is equal to or larger than two, the grooves have different depths, and depth of the grooves increases toward a region just below the light-emitting diode chip.

[0021] In the light-emitting device of claim 14 according to claim 8, a number of the at least one groove is equal to or larger than two, the grooves have different depths, , the LED chips are mounted face-down on the mount base (flip chip), and depth of the grooves increases toward a region just below the bonding material.

[0022] In the light-emitting device of claim 15 according to claim 8, a number of the at least one groove is equal to or larger than two, the LED chips are mounted face-down on the mount base (flip chip), and density of the grooves increases toward a region just below the bonding material.

[0023] In the light-emitting device of claim 16 according to claim 8, a number of the at least one light-emitting diode chip is equal to or larger than two, a number of the at least one groove is equal to or larger than two, and density of the grooves increases toward a region just below a central light-emitting diode chip in the light-emitting diode chips.

[0024] In the light-emitting device of claim 17 according to claim 8, a number of the at least one light-emitting diode chip is equal to or larger than two, a number of the at least one groove is equal to or larger than two, the grooves have different depths, and the grooves have deeper depth in a region between a central light-emitting chip among the at least one light-emitting diode chip and the exposed portion of the metallic plate than in the other regions.

Advantages of the Invention

[0025] According to the invention of claim 1, because the mount base makes thermal contact with the metallic plate in a portion wherein the pattern layer is exposed, a heat transfer path from the mount base to the metallic plate is secured, and heat generated in the LED chip(s) can be let out towards the circuit board quickly. Because the electrically conducting lines formed on said submount are extended towards the electrically conducting lines of the circuit board, the formers can be connected electrically to the latters. Further,

Because the electrically conducting lines formed on said submount are extended towards the electrically conducting lines of the circuit board, the mount base and the circuit board can be connected electrically with a reflow process of solder. By using only one reflow process, the mount base can be connected electrically to the circuit board, and a heat transfer path is formed via thermal contact with the metallic plate. Thus, a fabrication process can be simplified than a prior art process while improving heat transfer performance.

[0026] According to the invention of claim 2, at least one of the mount base and the plate has a protrusion at which they make contact with each other, so that the mount base and the plate make contact surely with each other, and direct contact becomes easy without an intervenient material.

[0027] According to the invention of claim 3, because the mount base and the plate are fitted at the protrusion and at the recess for thermal contact, the heat transfer area is increased to improve heat transfer. Further, in the step of mounting the mount base on the plate, the mount base can be positioned precisely.

[0028] According to the invention of claim 4, because throughholes are provided in the plate, for example, a metallic material having higher thermal conductivity than the plate can be interposed between the mount base and the plate to improve thermal conductance, and heat can be transferred directly from the bonding material for face down of the LED chips.

[0029] According to the invention of claim 5, the throughholes are provided on the mount base, and they filled with a material having a higher thermal conductivity than the mount base. Thus, the thermal conduction is improved than a path through the mount base. For example, a material having high thermal conductivity is filled in the throughholes. Alternatively, a metallic plate of the circuit board may be fitted to the throughholes. Then, the adhesive material for the LED chip makes thermal contact with the metallic plate via the throughholes having small heat resistance, so that heat generated in the LED chip(s) can be transferred to the metallic plate quickly.

[0030] According to the invention of claim 6, by using a metallic member is provided between the mount base and the circuit board, thermal contact between them is realized with the metallic block between opposing planes. Thus, this has a similar advantage to the above example where at least one of the mount base and the plate has a protrusion for improving thermal contact between them.

[0031] According to the invention of claim 7, because the mount base is made of a ceramic material, heat transfer is improved in contrast to the mount base made of a resin.

[0032] According to the invention of claim 8, by providing at least one groove, the strength of the mount base is kept high while decreasing the thickness of the base plane thereof. For example, a material for improving heat transfer can be filled in the groove, or heat can be transferred with a wind blow. Thus, the heat transfer of the LED chip can be improved.

[0033] According to the invention of claim 9, the groove has a bottom and two sides in a section, a width between the two sides increasing in a direction from the bottom toward an opening of the groove. For example, when a recess is provided on the mount base, and the LED chip is mounted on the recess, the groove can be provided hear the sides for forming the recess. Thus, the thickness of the sides can be decreased. Further, by filling a heat conducting material in the groove or introducing wind through it, the total heat transfer performance can be improved, heat transfer towards the circuit board is accelerated, and the heat transfer from the LED chip can be improved more than the invention of claim 8.

[0034] According to the invention of claim 10, because a thermal conductivity higher than the mount base is included inside the grooves, heat transfer from the mount base to the plate is improved, and the heat transfer of the LED chips is improved more than the invention of claim 8.

[0035] According to the invention of claim 11, because the grooves are provided just below the LED chips hear the heat source, the advantages of the grooves for heat transfer can be concentrated on the LED chips, and the heat transfer of the LED chips is improved more.

[0036] According to the invention of claim 12, a number of the at least one groove is equal to or larger than two, and the density of the grooves increases toward a region just below the light-emitting diode chip. Thus, the effect of heat transfer of the grooves is concentrated for the LED chips, and the heat transfer performance of the LED chips can be improved more than a case where the grooves have the same depth.

[0037] According to the invention of claim 13, a number of the at least one groove is equal to or larger than two, the grooves have different depths, and depth of the grooves increases toward a region just below the light-emitting diode chip. Thus, the heat transfer performance of the LED chips can be improved more than a case where the grooves have

the same depth.

[0038] According to the invention of claim 14, a number of the at least one groove is equal to or larger than two, the grooves have different depths, the LED chips are mounted face-down on the mount base, and the depth of the grooves increases toward a region just below the bonding material. Thus, the effect of heat transfer of the grooves is concentrated for the LED chips, and the heat transfer performance of the LED chips can be improved more than a case where the grooves have the same depth.

[0039] According to the invention of claim 15, a number of said at least one groove is equal to or larger than two, the LED chips are mounted face-down on the mount base (flip chip), and density of the grooves increases toward a region just below the bonding material. Thus, the effect of heat transfer of the grooves is concentrated for the LED chips, and the heat transfer performance of the LED chips can be improved more than a case where the grooves are distributed evenly.

[0040] According to the invention of claim 16, a number of said at least one light-emitting diode chip is equal to or larger than two, a number of said at least one groove is equal to or larger than two, and density of the grooves increases toward a region just below a central light-emitting diode chip in the light-emitting diode chips. Thus, the effect of heat transfer of the grooves is concentrated for the LED chips, and the heat transfer performance of the LED chips can be improved more than a case where the grooves are distributed evenly.

[0041] According to the invention of claim 17, when grooves are provided, they have different depths, and the depth is deeper in a region between a central light-emitting chip among the light-emitting diode chips than in the other regions. Thus, the effect of heat transfer of the grooves is concentrated for the LED chips in the central region expected to be heated more, and the heat transfer performance of the LED chips can be improved more than a case where the grooves has the same depth.

Best Mode for Carrying Out the Invention

[0042] Light-emitting devices of several embodiments of the invention are explained below with reference to the appended drawings. Fig. 1 shows a light-emitting device 200. In the light-emitting device 200, a bottom 11 of a submount 100 for LED contacts thermally with a metallic plate 30 of a circuit board 300. The submount 100 has a mount base 10 having electrically conducting lines 12-14 and 13-17 and a light-emitting diode (LED) chip 5

mounted on the mount base 10. The circuit board 300 has the metallic plate 30 and a metallic pattern 41 for electrical conduction formed on an electrically insulating layer 40. The LED chip 5 has a gallium nitride semiconductor. In this and following embodiments, the LED chip 5 has a gallium nitride semiconductor, but not limited thereto.

[0043] The submount 100 has the mount base 10 having a recess like a cup for mounting the LED chip 5 on the center thereof. Further, it has the electrically conducting lines 12-14 on the submount 100 to extend from near the bottom of the cup in the right direction towards a bottom of a lower step of the plate, and the other electrically conducting lines 13-17 to extend from near the bottom of the cup in the left direction towards the bottom. The submount 100 usually has a symmetrical form with respect to rotation around an axis of the T-character-like form, but its shape is not limited thereto. For example, it may be rectangular.

[0044] The LED chip 5 is bonded to the bottom of the cup on the mount base 10 with a die bonding material, and the two electrodes (not shown) provided on a top thereof are bonded with wires 6 to the portions 12, 15 provided for wiring in the electrically conducting lines.

[0045] Further, a part of the metallic plate 30 of the circuit board 300 is exposed, and the submount 100 is mounted to the exposed portion by thermally contacting a bottom plane of the protrusion 11 opposite to the top plane for mounting the LED chip 5. The portion where the bottom plane of the mount base 10 contacts with the exposed area of the metallic plate 30 is hereinafter referred to as thermal contact portion 1. The electrically conduction lines 12-14, 15-17 are bonded with solder 42 to the patterns 41 of the circuit board 300. In this structure, a heat transfer path is provided from the mount base 10 to the metallic plate 30 so that the heat generated in the LED chip 5 can be led to the circuit board 300 readily.

[0046] Further, the fabrication process can be simplified by using a solder reflow step for electrical connection for the electrical pattern 41 of the circuit board 300 wherein the thermal contact can be formed simultaneously between the mount base 10 and the circuit board 30 to improve the heat transfer efficiency. The heat transfer efficiency can be improved further by forming a metallic layer on the plane of the mount base 10 opposite to the metallic plate 30, and by bonding it with solder to the exposed area of the metallic plate 30. This also holds for the other embodiments to be explained later.

[0047] As explained above, the submount 100 is mounted on the circuit board 300

wherein a portion of the metallic plate 30 is exposed and the exposed portion makes contact thermally with the protrusion 11 of the mount base 10. Thus, a heat transfer path from the mount base 10 to the metallic plate 30 is secured, and heat generated by the LED chips 5 can be led quickly to the metallic plate 300. When the conduction lines 14 and 17 on the mount base are connected electrically to the conduction pattern on the circuit board 300 with a solder reflow, the thermal contact 1 is formed simultaneously between the mount base 10 and the circuit board 300 to provide a heat transfer path. Thus, the fabrication process can be simplified than a prior art process, and heat transfer performance can be improved. Further, by forming a metallic layer on a plane of the mount base 10 opposing the metallic plate 30 and adhering it to the exposed portion of the metallic plate 30 with solder, the heat transfer performance can be improved more. This is also observed similarly in the circuit boards to be explained below.

[0048] Next, a light-emitting device of a different embodiment is explained. Fig. 2 shows a light-emitting device 201. This light-emitting device 201 is similar to the light-emitting device 200 of the first embodiment except that the mount base 10 of a submount 101 has a flat top plane for mounting the LED chip 5. For example, when the submount 101 is difficult to have a recess on the top plate of the mount base 10, for example, if it is made of a ceramic material, or when it is not needed to have a recess on the top plate, this type of submount can be used for mounting the LED chip 5.

[0049] Next, a light-emitting device of a different embodiment is explained. Fig. 3 shows a light-emitting device 202. In the light-emitting device 202, a submount 102, wherein an LED chip 50 is mounted face down on the mount base 10 (flip chip bonding), is mounted on a circuit board 302. The mount base 10 has a flat bottom plate without a protrusion, while the circuit board 302 has a protrusion 31 at the exposed area. The bonding between the submount 102 and the circuit board 302 and the like are similar to the above-mentioned light-emitting devices.

[0050] The LED chip 50 and the face down mounting thereof are explained below. The LED chip 50 has a transparent crystalline plate 60, an n-type semiconductor layer 61 and a p-type semiconductor layer 64 layered successively thereon, and electrodes 62, 65 formed on the semiconductor layers. Further, an electrically insulating layer 67 and a metallic layer 68 are formed successively on the p-type semiconductor layer 64. The LED chip 50 is mounted on the cup of the mount base 10 by setting the transparent crystal plate 60

upside and the electrodes 62, 65 downside (face down).

[0051] A dummy pattern 18 is formed, besides the electrically conducting lines 12, 15, at the bottom of the cup of the mount base 10. Bonding materials 63, 66, 69 are provided beforehand on the patterns at the bottom for bonding them with the electrodes of the LED chip 50. The n-type semiconductor layer 61 is electrically bonded with the bonding material 63 between the electrode 62 and the pattern 12 on the mount base 10. The p-type semiconductor layer 64 is electrically bonded with the bonding material 66 between the electrode 65 and the pattern 15 on the mount base 10. Further, the metallic layer 68 on the LED chip is bonded with the bonding material 69 to the dummy pattern 18 on the mount base 10.

[0053] The bonding materials 63, 66, 69 are made of a metal such as gold or an alloy for stud bumps or of solder for solder bumps. By using such bonding materials, thermal bonding between the LED chip 50 and the mount base 10 can be improved more than the wire bonding, so that the heat transfer efficiency can be improved. The number of the bonding material may be one for each of the electrodes 62 and 65, but the heat transfer efficiency can be improved further by providing a plurality of bonding materials for each electrode.

[0054] If openings of necessary areas for bonding are formed on insulating layers formed on the electrodes and on the semiconductor layers, a possibility of shortening between the bonding materials can be decreased, so that more bonding materials can be used. Alternatively, a part of the insulating layer 67 is metallized to form the metallic layer 68 insulated from the other electrodes 62 and 65, the size of the area for bonding can be increased besides the bonding for the other electrodes 62, 65, and this enhances thermal contact.

Fig. 4(a) is a sectional view of a submount 103 for LED of a light-emitting device 203 of a further embodiment of the invention, and Fig. 4(b) is a sectional view of the light-emitting device 203. The submount 103 has a structure that the mount base 10 has throughholes 20 extending from the bottom of the recess on the top for mounting the LED chip 50 to the bottom plate of the mount base 10. The size of the throughholes 20 is increased towards the bottom of the mount base 10, and metallic layers 21 are formed on the inner surfaces of the throughholes 20 with soldering or the like, similarly to the pattern 12. When the submount 103 is mounted on a circuit board 303, the metallic layers 21 on

the throughholes 20 are connected with the solder 43 to the exposed metallic area of the metallic plate 30 of the circuit board 303. In this structure, because heat generated in the LED chip 50 conducts through the metallic layers 21 having thermal conductivity higher than a conventional mount base towards the circuit board 303. Then, the heat transfer efficiency can be improved further.

[0055] Next, a light-emitting device of a different embodiment is explained. Fig. 5 shows a light-emitting device 204 with the mount base 10 having throughholes 20. The light-emitting device 204 is different from the light-emitting device 203 shown in Figs. 5A and 5B in that a submount 104 has a protrusion 11 at the bottom thereof. The metallic plate 30 of the circuit board 300 has a flat exposed area. A similar advantage to the previous embodiment can be realized in this structure.

[0056] Fig. 6 shows a submount 105 of a further embodiment of the invention having throughholes filled with a filler 23 such as copper, silver or solder having a higher thermal conductivity than the mount base 10. Thus, the heat transfer efficiency can be improved further than the light-emitting device shown in Figs. 5A, 5B and 6.

[0057] Next, a light-emitting device of a different embodiment is explained. Fig. 7 shows a light-emitting device 206. A submount 106 of the light-emitting device 206 is similar to the mount base 10 of the submount 102 shown in Fig. 4 except that V-character type recesses 19 are formed at the bottom of the mount base 10 of the submount 106. A circuit board 306 is similar to the circuit board 302 shown in Fig. 3 except that it has V-character-like projections 32 in a protrusion 31 of the metallic plate 30 of the circuit board 302 in correspondence to the recesses 19. The light-emitting device 206 is fabricated by fitting the projections 32 of the metallic plate 30 to the recesses 19 of the submount 106. In this structure, the contact area between the mount base 10 and the metallic plate 30 can be enlarged. Then thermal contact between them becomes sure, the thermal resistance between them is decreased, and the heat transfer efficiency for the LED chip 50 is improved. Further, the aligning of the submount 106 and the circuit board 306 can be performed easily in a step for mounting the submount 106 to the circuit board 306.

[0058] Next, five types of light-emitting devices of a different embodiment are explained. Figs. 8 to 11 show light-emitting devices 207 to 210 having different combinations on the structure of thermal contact between the submount and the circuit board. First, in the light-emitting device 207 shown in Fig. 8, the position of the protrusion in the light-emitting

device shown in Fig. 1 is changed upside down. That is, in the light-emitting device 200 shown in Fig. 1, the exposed area of the metallic plate 30 of a circuit board 308 is flat, while in the light-emitting device 207, the exposed area has a protrusion 31 which contacts with the flat bottom of the mount base 10. In this case, the distance between the LED chip 5 and the metallic plate 30 becomes shorter than the counterpart in the light-emitting device 200 shown in Fig. 2, so that the heat transfer efficiency is improved.

[0059] On the other hand, in the light-emitting devices 208, 209 and 210 shown in Figs. 9, 10 and 11, one of the bottom plane of the mount base 10 and the exposed area of the metallic plate 30 has a protrusion, while the other has a recess, and the protrusion is fitted to the recess. It is to be noted that the light-emitting devices 209 and 210 have structures with double combinations of protrusion and recess wherein a protrusion or recess has further an inner recess or protrusion. In these structures where the recesse(s) are fitted to the protrusion(s), the aligning of the submount with the circuit board can be performed more precisely in the fabrication process while keeping heat transfer efficiency.

[0060] In the light-emitting device 209 shown in Fig. 10, a recess 33 is formed in a protrusion 31 of the metallic plate 30, and the recess 33 of the metallic plate 30 is fitted to the protrusion 11 of the mount base 9. In this structure, the thermal contact area at the thermal contact 1 of the circuit board 309 with the mount base 10 of the submount is larger than that in the light-emitting device 208 shown in Fig. 10, so that the heat transfer efficiency is improved further.

[0061] The light-emitting device 210 shown in Fig. 11 has a similar structure to the light-emitting device 208 shown in Fig. 9 except that a recess is formed in a protrusion 11 of the mount base 10 to be fitted to a protrusion 31 of the metallic plate 30. Therefore, similar to the light-emitting device 208, the contact area between the metallic plate 30 and the mount base 10 is larger than that of the light-emitting device 208, and the distance between the LED chip 5 and the metallic plate 30 is shorter, so that the heat transfer efficiency is improved further.

[0062] Next, a light-emitting device of a different embodiment is explained. Fig. 12 shows a light-emitting device 211. In the light-emitting device 211, the protrusion 11 in the light-emitting device 200 shown in Fig. 2 is replaced with a metallic plate 25 having a higher thermal conductivity. Therefore, the thermal resistance is decreased more than in the light-emitting device 200 shown in Fig. 1 to improve the heat transfer efficiency.

Alternatively, a circuit board 300 may have a thin insulator layer 40 (for example, a thickness equal to or smaller than about 100 micrometers) and a layer is formed with solder, silver paste or the like instead of the metallic plate 25.

[0063] Next, an application of a light-emitting device of a different embodiment is explained. Figs. 13 and 14 show applications of the above-mentioned light-emitting devices. Fig. 13 shows an application of one 208 of the above-mentioned light-emitting devices for a backlight of a liquid crystal display, a lighting portion of a traffic sign or the like. In order to emit a light of a desired lighting color, an LED chip 5 for emitting a predetermined color is selected, and it is combined with a fluorescent member 81 including a fluorescent material having a function to convert the color. The light having the desired color is obtained by the LED chip 5 and the fluorescent member 81, and it enters into a guiding plate 82 to be guided towards a display section (not shown) and emitted to the outer space.

[0064] Further, in the application shown in Fig. 14, a light is obtained by the light-emitting device 208 combined with a fluorescent member 81 as mentioned above, and it is entered to an optical component 83 having a lens part 84, and the light condensed by the lens part 84 is transmitted in a predetermined direction.

[0065] Next, a light-emitting device of a different embodiment is explained. Fig. 15 shows a submount 114 for a light-emitting device. In the above-mentioned embodiments having the submount with the face down LED chip as shown in Fig. 3, the bonding materials 69 are isolated electrically from the other electrode 65. In the submount 114, bonding materials 69 are connected to a portion extended from the electrode 65 on the p-type semiconductor layer 64. In this structure, no new electrode is needed for connecting the bonding materials 69, and the fabrication process becomes simpler.

[0066] Next, a light-emitting device of a different embodiment is explained. Figs. 16 and 17 show submounts 115, 116 for light-emitting device 215, 216. These light-emitting devices have different types of the submount. The electrically conducting lines of the mount base 10 are not extended so as to have a section parallel to the metallic pattern 41 of the circuit board 300.

[0067] In the light-emitting device 215 shown in Fig. 16, the submount 115 is mounted to the circuit board 300 by bonding the electrically conducting lines 13, 16 of the mount base 10 with a solder 42 to the metallic pattern 41 of the circuit board 300. The submount 115

is bonded at two sides thereof with solder 42, while in the light-emitting device 200 shown in Fig. 2 the submount 100 is bonded with solder 42 at the bottom side thereof. Because the submount 115 does not have electrically conducting lines at the bottom thereof, the fabrication process becomes simpler. Further, because no solder layer is present between the submount 115 and the circuit board 300, the size of the lighting device does not change due to the solder layer. Then the size in this direction can be set precisely, and the reliability of the thermal contact becomes higher.

[0068] In the light-emitting device 215 shown in Fig. 17, a top of the mount base 10 has planes inclined towards the circuit board 300, and the electrically conducting lines 12, 15 are extended thereon. Similarly to the submount shown in Fig. 17, no solder layer is present between the submount 115 and the circuit board 300, so that the fabrication process becomes simpler. Further, because the top of the submount is not flat and shoulders thereof become lower, the amount for the mount base can be decreased, and the size of the lighting device does not change due to the solder layer.

[0069] Next, modifications of the above-mentioned embodiments are explained. In the light-emitting devices 203 and 204 shown in Figs. 5 and 6, the thermal contact 1 between the submount and the exposed area of the metallic plate is bonded with solder, while in the others the submount contacts with the exposed area of the metallic plate at the thermal contact 1 without an intermediate member between them. In the others a metallic layer may be formed at the bottom of the mount base, and the submount may be bonded with solder to the exposed area of the metallic plate. Then the heat transfer efficiency may be increased further. In the fabrication process, the solder layer may be formed at the thermal contact, simultaneously in the reflow step as the electrical connection for the patterns.

[0070] When a solder layer is formed at the thermal contact 1, it is preferable that the position of the thermal contact is lower than the height of the pattern 41 of the circuit board. For example, in the light-emitting device 200 shown in Fig. 11, when the thermal contact is soldered, it can be prevented that the patterns 14 and 17 are short-circuited with solder. In the light-emitting devices 208 and 210 shown in Figs. 9 and 11, the contact portions at the most outside are still lower than the insulator layer of the circuit board 309, 310, so that the short-circuit at the thermal contact can be prevented surely.

[0071] Next, a series of light-emitting devices are explained having one or more grooves

at a plane of the mount base 10 of the submount in contact with the metallic plate 30 of the circuit board. As explained above in the background art, a part of the energy is outputted as a light emitted from the p and n layers of the LED chip, but a large part thereof is converted to heat. A part of the heat generated in the LED chip is transferred to the outside in the forms of convection and thermal radiation, but a large part thereof conducts through the bonding materials or the like to the mount base, and further through the solder at the bottom thereof to the circuit board and radiated from the surface of the circuit board,

[0072] In the conduction path mentioned above, heat resistance is largest in the mount base having low thermal conductivity (0.3-10 W/mK). The heat resistance is proportional to the thickness of the mount base in the thickness direction and is inversely proportional to the thermal conductivity. Therefore, it is desirable that the thickness of the mount base below the LED chip is small. However, the decrease in the thickness of the mount base below the LED chip, or the main conduction path, makes it difficult to form the mount base. Further, this decreases the strength of the mount base, so that the mount base is liable to be broken in a fabrication step for mounting the LED chip to the mount base. Then one or more grooves are formed on the mount base as explained below, so that the mount base can be formed easily while keeping the strength thereof, while the thermal resistance of the mount base can be decreased substantially.

[0073] Fig. 18 shows a first example of a light-emitting device of having grooves on the mount base. In this example, a plurality of grooves (concave portions) are provided in parallel to each other on the bottom of the mount base 10. As shown in Fig. 18, an LED chip 50 is mounted face down on the bottom of a recess formed at the top of the mount base10 of a submount 117 with bonding members 51 (flip chip). The mount base 10 is made of, for example, alumina, and has a protrusion 11 at the bottom thereof. As shown in Fig. 18, three grooves 7 are formed in parallel at the center of the protrusion 11. The grooves 7 are positioned to pass through an area 50a, which is a projection image of the LED chip 50 in the vertical direction, in order to radiate heat efficiently. That is, the average thickness of the mount base 10 below the LED chip 50 becomes smaller, or the heat resistance at this area is decreased.

[0074] When the submount 117 is mounted on the circuit board 300, as shown in Fig. 18(c), a solder layer 7 is formed between the bottom of the mount base 10 and the top of the circuit board 300. The solder layer 30 also fills the grooves 7, so that the average heat

resistance between the LED chip 50 and the metallic plate 30 is further decreased by providing the solder layer 7.

[0075] By using the structure having the above-mentioned grooves 7, even for a mount base made of a relatively brittle material such as alumina the thickness can be decreased while keeping the strength. Further, a metallic film may be formed, for example, with copper plating having higher thermal conductivity (313 W/mK). The thermal resistance can be decreased further to a large extent by filling solder (thermal conductivity, 50 W/mK) into the grooves 7. Because the thermal resistance of the mount base 10 below the LED chip 50 as the main conduction path is decreased, the temperature rise of the LED chip 50 can be decreased. Deposition or the like may be used for forming the metallic film. The metallic film may be made of copper, gold, silver or the like having a higher thermal conductivity than the mount base 10 and having good wetness for bonding. By providing a copper film or the like on the surface of the grooves 7, the transfer of heat from the mount base 10 to the metallic plate 30 is facilitated. The filler for filling the grooves 7 as an auxiliary material for heat transfer is not limited to the above-mentioned solder. For example, silver paste, silicone resin or the like may be used having higher thermal conductivity than the mount base 10. The auxiliary material for heat transfer may be a soldered metallic wire such as a soldered copper wire.

[0076] As shown in Fig. 18(d), the grooves 7 may have side walls with a space between them increasing from the bottom to the opening thereof. Because the grooves 7 are broadened towards the openings thereof, the heat transfer from the mount base 10 to the metallic plate 30 of the circuit board is facilitated more than the grooves shown in Fig. 18(c). Further, in this structure of the grooves 7, the filler such as solder can be filled into the grooves 7 while suppressing the generation of bubbles. Therefore, this structure is advantageous for improving the heat transfer efficiency.

[0077] Fig. 19 shows a modified example of the above-mentioned light-emitting device. The submount 117 has the protrusion 11 similarly to the submount 100 shown in Fig. 1 below the mount base 10, while a submount 118 of this example without a protrusion may have grooves 7 at the bottom of the mount base 10. As shown in Fig. 19, the grooves 7 can be formed in parallel on the entire bottom.

[0078] When the submount 118 is mounted on the circuit board 300, as shown in Fig. 19(c), the circuit board 300 may have a thin insulator layer 40 (for example, equal to or

smaller than about 100 micrometers), and the submount 118 may be mounted directly on the metallic plate 30 of the circuit board 300 by using a solder layer 43 formed by the bonding besides the bonding with solder 42 for the conduction layers.

[0079] Alternatively, when the submount 118 is mounted on the circuit board 300, the plate 300 having a protrusion as shown in Fig. 3 may be used to contact with the bottom of the mount base 10. Alternatively, as shown in Fig. 19(d), a metallic member 25a having protrusion to be fitted with the grooves 7 may be interposed between the mount base 10 and the metallic plate 30.

[0080] Next, a result of conduction simulation is explained on the light-emitting device having the submount 117, 118 with the above-mentioned grooves 7. The conduction simulation is performed on three cases where the heating condition of the LED chip and the ambient temperature are kept the same. In a first case, the grooves are not provided on the bottom of the mount base 10; in a second case the grooves 7 are provided on the mount base 10 at equal distance between them; and in a third case the grooves 7 are provided on the mount base 10 so that the total volume of the spaces in the grooves is the same as in the second case, but the grooves 7 are provided just below the bonding materials of the LED chip 5. The simulation result shows that the temperature of the LED chip 5 is decreased in the order of the first case, second case and the third case. If the temperature of the LED chip 5 in the first case is set to 100, it deceases to 83 for the second case and to 77 in the third case. Therefore, it is found that if the grooves 7 are provided just below the bonding materials 51 of the LED chip 50, the heat transfer efficiency is improved further, and the temperature rise or the LED chip 50 can be decreased.

[0081] Fig. 20 shows a light-emitting device of a further embodiment of the invention having a groove structure. In the light-emitting device the grooves 7 just below the bonding members 51 have the depth thereof deeper than the others. In this structure of the grooves 7, the thickness of the mount base 10 just below the LED chip 50 can be decreased further without decreasing the strength of the mount base 10. Then the thermal resistance from the LED chip 50 to the metallic plate 30 can be decreased further, and the temperature rise of the LED chip 50 can be lowered.

[0082] Fig. 21 shows a light-emitting device of another embodiment of the invention having a groove structure. In the light-emitting device, the grooves 7 are arranged so that grooves 7 just below the bonding members 51 have the deepest depth, while grooves

adjacent to one of the grooves having the deepest depth have depths decreasing stepwise with increase in the distance from the one of the grooves having the deepest depth. Similarly to the light-emitting device shown in Fig. 20, the thickness of the mount base 10 just below the LED chip 50 can be decreased further without deteriorating the strength of the mount base 10. Then the thermal resistance from the LED chip 50 to the metallic plate 30 can be decreased further, and the temperature rise of the LED chip 50 can be lowered.

[0083] Fig. 22 shows a light-emitting device of a further embodiment of the invention having a groove structure. In the light-emitting device, a wide recess 71 is provided in the bottom of the mount base 10 below the LED chip 50, and grooves 7 are provided inside the recess 71 below the bonding materials 51 for the LED chip 50. Because the recess 71 is wide and the depth of the grooves 7 is shallower than the counterparts in Fig. 21, solder enters into and fills the grooves 7 more easily.

[0084] Figs. 23-26 show light-emitting devices of further embodiments of the invention having a groove structure and a plurality of LED chips 50. In the light-emitting devices, the LED chips 50 are mounted adjacent to each other at a center of the mount base 10, while grooves (or recesses) 7 are provided on the mount base 10 below the LED chips 50. In the light-emitting device shown in Fig. 23, the grooves 7 have the same size. In the light-emitting device shown in Fig. 24, the depth of the groove 7 is deepest for the central LED chip 50 among the plurality of LED chips 50 and becomes shallower at both sides thereof according to the distance from the central groove for the central LED chip 50. In the light-emitting device shown in Fig. 25, a plurality of grooves of narrow width are provided for each of the LED chips 50, and the number or the density of the grooves below an LED chip 50 becomes highest for the central LED chip 50.

[0085] Further, the light-emitting device shown in Fig. 26 has grooves 7 similarly to those shown in Figs. 25 and 26, but the grooves for the central LED chip 50 have the highest density and the deepest depth. Then, the central LED chip 50 can radiate heat efficiently, so that the temperature distribution of the LED chips 50 can be made even.

[0086] Figs. 27 to 30 show light-emitting devices of further embodiments of the invention having a groove structure similarly to those shown in Figs. 23 to 26, but having LED chips 55 mounted faceup. The LED chips 55 are mounted with a bonding material 57 such as a die bonding member or a plated layer. The electrical connection to electrodes 56 of the LED chips 55 is performed with wire bonding. In the light-emitting devices, the structure of

the grooves 7 has an advantage to make temperature distribution even and to radiate heat efficiently, similarly to the above-mentioned light-emitting devices.

[0087] Next, Figs. 31(a) and (b) show a submount 119 of a further embodiment of the invention having a groove structure. In the submount 119, as shown in Fig. 31(b), grooves 7 are formed on the bottom (or rear) thereof in vertical and transverse directions. When the submount 119 is mounted on the circuit board 300, solder or the like is interposed between the bottom of the submount 119 and the circuit board, and as shown above in Fig. 19, it is filled into the grooves 7.

[0088] In the structure of the mount base 10, the grooves 7 can be formed vertically and transversely at a higher density than the counterparts shown in Figs. 18 and 19 wherein the grooves 7 are arranged only in one direction, without decreasing the strength of the mount base 10. Further, the heat can be radiated efficiently from the LED chip 50 to the circuit board 30, and the temperature of the LED chip 50 can be decreased further. Further, because the grooves 7 are formed both vertically and transversely, air may leak easily from a side plane of the protrusion when solder 53 is filled into the grooves 7. Therefore, it becomes easier to fill solder into the grooves 7. Further, because the thermal conductivity of solder 43 is higher than the mount base 10, heat can be radiated efficiently. If the LED chip 50 is mounted above the crossings of the vertical and transverse grooves, the heat transfer can be performed more efficiently.

[0089] Fig. 32 shows a submount of a further embodiment of the invention having a groove structure. Grooves 7 are provided to extend radially from the center of the protrusion 11 of the mount base 10. Though only one LED chip (not shown) is mounted in this example above an area 50a at the center of the protrusion 11, a plurality of LED chips may be mounted. When a plurality of LED chips are mounted, they may be mounted radially from the optical viewpoint. In such a case, when the above-mentioned radial grooves 7 are formed, the thickness of the mount base 10 just below the central LED chip among them can be decreased. Then, heat transfer from the LED chips to the metallic plate is improved, and the temperature of the LED chips can be lowered on the average.

[0090] Fig. 33 shows a submount of a further embodiment of the invention having a groove structure. Grooves 7 are formed densely in some areas and coarsely in other areas at the bottom of the mount base 10. Especially, the grooves 7 are formed densely at the central area so that the thickness of the mount base 10 just below the LED chip can

be decreased, and heat transfer from the LED chips to the pattern plate is improved.

[0091] Figs. 34(a) and (b) show a submount 120 of a further embodiment of the invention having a groove structure. Deep wells 72 are formed on the bottom of the mount base 10 in an area 50a just below the bonding members for the LED chip 50, and grooves 7 are formed vertically and transversely through the wells 72. Solder is filled into the grooves 7 and the wells 72 between the bottom of the mount base 10 and the metallic plate of the pattern plate (not shown). The numbers of the grooves 7 and the wells 72 and the positional relationship thereof are not limited to the example shown in Figs. 35A and 35B. Because deep wells 72 are formed in the above-mentioned structure below the LED chip for the main heat transfer path for the LED chip, the thickness of the mount base 10 just below the LED chip can be decreased. Then, heat transfer from the LED chip to the metallic plate is improved, and the temperature of the LED chip can be lowered.

[0092] Fig. 35 shows a submount of a further embodiment of the invention having a groove structure. Grooves 7 extend radially from a center of the protrusion 11 of the mount base 10, and the other grooves 7a are formed concentrically on the protrusion 11. When a plurality of LED chips are mounted, they may be mounted radially from the optical viewpoint. In this example, the above-mentioned grooves 7, 7a are formed radially around each of the LED chips to be mounted above areas 50a. Then, the thickness of the mount base 10 just below LED chip(s) can be decreased. Then, heat transfer from the LED chip(s) to the circuit board is improved, and the temperature of the LED chip(s) can be lowered.

[0093] Fig. 36 shows a submount of a further embodiment of the invention having a groove structure. Grooves 7 are formed radially around each of the LED chips to be mounted above areas 50a. Then, when a plurality of LED chips are mounted, the thickness of the mount base 10 just below LED chips can be decreased. Then, heat transfer from the LED chips to the circuit board is improved, and the temperature of the LED chips can be lowered.

[0094] Figs. 37 and 38 show submounts of further embodiments of the invention having a groove structure. In the submount shown in Fig. 37, one spiral groove 7 is formed on the protrusion 11 on the bottom of the mount base 10, while in the submount shown in Fig. 38, one groove 7 is formed serpentinely on the protrusion 11 on the bottom of the mount base 10. When the submount is mounted on a metallic plate of the circuit board (not shown), a

solder layer for bonding is interposed between the submount and the metallic plate.

[0095] In the groove shown in Fig. 37 or 38, a soldered metallic wire such as a soldered copper wire may be inserted therein as an auxiliary material for facilitating heat transfer. A metallic wire or a copper wire has a higher thermal conductivity than the mount base 10 and than the solder. Therefore, by inserting the wire, the heat resistance can be decreased more. Because only one groove 7 is formed on the bottom of the protrusion 11 of the mount base 10, it is easy to insert the wire in the groove 7.

[0096] Figs. 39(a) and (b) show a submount 121 of a further embodiment of the invention having a groove structure. Two recesses (grooves) 73 are formed in parallel at the bottom of the mount base 10 outside an area just below the LED chip 50. A solder layer 43 for bonding is interposed between the mount base 10 and the metallic plate 30 of the circuit board 300. In this structure having the recesses 73, a length along the surface of the mount base 10 from the thermal contact (the solder layer 43) to an electrical contact (solder 42) between the electrically conducting line and the pattern 41 of the circuit board 300 becomes longer, so that electrical short-circuit between them can be suppressed.

[0097] Figs. 40(a) and (b) show a submount 122 of a further embodiment of the invention having a groove structure. Recesses 74 are formed similarly to, but having a larger size than the recesses 73 shown in Fig. 39. As shown in Fig. 41A, the recesses 74 have a bottom plane and two side planes extending between the bottom plane and the opening of the recess 74, and the width of the recess becomes wider towards the opening thereof.

[0098] In the structure having the recesses 74, similarly to the submount shown in Fig. 40, a length along the surface of the mount base 10 from the thermal contact (the solder layer 43) to the electrical contact (solder 42) between the electrically conducting line and the metallic pattern 41 of the circuit board 300 becomes longer, so that electrical short-circuit between them can be suppressed. Further, an area for heat transfer is widened, and the heat transfer is improved. Further, the mount base 10 shown in Fig. 40 can be fabricated easily with injection molding as a three-dimensional circuit board because the difference of the thickness of the mount base 10 is not so large, and the amount of a material for injection molding can be reduced.

[0099] Fig. 41 shows a submount 123 of a further embodiment of the invention having a groove structure. The mount base 10 has recesses (grooves) 74 similar to those shown in Fig. 40, and a metallic layer 74a is formed on a side plate in the recess. The metallic

layer 74a may be formed with plating with silver or other metal such as copper or nickel. Alternatively, a white paint may be applied. Then, besides the above-mentioned advantages on the submount shown in Figs. 41A and 41B, it is advantageous that the metallic layer 74a can reflect a part or all of light emitted by the LED chip 50 and transmitting the mounting layer 10. Thus, stray light in lateral directions can be taken out to the top plane, so that the efficiency of using the emitted light can be increased.

[0101] Fig. 42 shows a submount 124 of a further embodiment of the invention having a groove structure. The mount base 10 has recesses 74 similar to those shown in Fig. 40. Further, air vents 75 are formed on the bottom of the mount base 10 from the inside of the recesses 74 to the side plane of the mount base 10 in a lateral direction. Then, heat transfer can be improved further due to the air vents 75 in the lateral direction.

[0102] Fig. 43 shows a submount 125 of a further embodiment of the invention having a groove structure. The mount base 10 has recesses 74 and air vents 75 similar to those shown in Fig. 42. Further, air vents 76 are formed from the inside of the recesses 74 to the top of the mount base 10 in the vertical direction. Then, heat transfer can be improved further due to the air vents in the vertical direction.

[0103] The above-mentioned embodiments can be modified in various ways. For example, the LED chip and the mount base in the submount are not limited to wire bonding, face down mounting and the like. In the above-mentioned embodiments, the mount base is made of alumina, but it may also be made of a ceramic other than alumina or a resin. The filler for the grooves is not limited to solder, and a material such as silver paste or silicone resin may also be used having a higher thermal conductivity than the mount base. Further, the number of the grooves and that of the LED chips are also not limited to the examples shown in the above-mentioned embodiments.

In the embodiments to be explained below, an additional path for heat transfer is added besides the thermal contact between the submount and the circuit board in order to improve the heat transfer efficiency further. Then the injection current for LED chips can be increased further.

Brief Description of Drawings

[0105]

Fig. 1 is a sectional view of a light-emitting device of an embodiment of the

invention.

Fig. 2 is a sectional view of a light-emitting device of another embodiment of the invention.

Fig. 3 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 4(a) is a sectional view of a submount for LED of a light-emitting device of a further embodiment of the invention, and Fig. 4(b) is a sectional view of the light-emitting device.

Fig. 5 is a sectional view of a further embodiment of a light-emitting device of an embodiment of the invention.

Fig. 6 is a sectional view of a submount for LED of a light-emitting device of a further embodiment of the invention.

Fig. 7 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 8 is a sectional view of a further embodiment of a light-emitting device of an embodiment of the invention.

Fig. 9 is a sectional view of another light-emitting device of a further embodiment of the invention.

Fig. 10 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 11 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 12 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 13 is a sectional view of an application of a light-emitting device of a further embodiment of the invention.

Fig. 14 is a sectional view of another application of a light-emitting device of the embodiment of the invention.

Fig. 15 is a sectional view of a submount for LED of a light-emitting device of a further embodiment of the invention.

Fig. 16 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 17 is a sectional view of a light-emitting device of a further embodimentof the invention;

Fig. 18(a) is a sectional view of a submount for LED of a light-emitting device of a further embodiment of the invention, Fig. 18(b) is a bottom plan view of the submount for LED, Fig. 18(c) is a sectional view of the light-emitting device, and Fig. 18(d) is a sectional view of a modified example of the light-emitting device;

Fig. 19(a) is a sectional view of a submount for LED of a light-emitting device of a further embodiment of the invention, Fig. 19(b) is a bottom plan view of the submount for LED, Fig. 19(c) is a sectional view of the light-emitting device, and Fig. 19(d) is a sectional view of a modified example of the light-emitting device;

Fig. 20 is a sectional view of a further embodiment of a light-emitting device of an embodiment of the invention.

Fig. 21 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 22 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 23 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 24 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 25 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 26 is a sectional view of a further embodiment of a light-emitting device of an embodiment of the invention.

Fig. 27 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 28 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 29 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 30 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 31(a) is a sectional view of a submount for LED of a light-emitting device of a further embodiment of the invention, and Fig. 31(b) is a bottom plan view of the submount.

Fig. 32 is a bottom plan view of a submount for LED of a light-emitting device of a further embodiment of the invention.

Fig. 33 is a bottom plan view of a submount for LED of a light-emitting device of a further embodiment of the invention.

Fig. 34(a) is a sectional view of a submount for LED of a light-emitting device of a further embodiment of the invention, and Fig. 34(b) is a bottom plan view of the submount for LED.

Fig. 35 is a bottom plan view of a submount for LED of a light-emitting device of a further embodiment of the invention.

Fig. 36 is a bottom plan view of a submount for LED of a light-emitting device of a further embodiment of the invention.

Fig. 37 is a bottom plan view of a submount for LED of a light-emitting device of a further embodiment of the invention.

Fig. 38 is a bottom plan view of a submount for LED of a light-emitting device of a further embodiment of the invention.

Fig. 39(a) is a sectional view of a light-emitting device of a further embodiment of the invention, and Fig. 39(b) is a perspective view of a submount for LED of the light-emitting device.

Fig. 40(a) is a sectional view of a light-emitting device of a further embodiment of the invention, and Fig. 40(b) is a perspective view of a submount for LED of the light-emitting device.

Fig. 41 is a sectional view of a light-emitting device of a further embodiment of the invention.

Fig. 42 is a perspective view of a submount for LED of a light-emitting device of a further embodiment of the invention.

Fig. 43 is a perspective view of a submount for LED of a light-emitting device of a further embodiment of the invention.

Fig. 44 is a sectional view of a prior art light-emitting device.

[Description of Signs]

[0106]

1: Thermal contact.

5, 50: LED chip.

7, 7a, 73-76: Groove.

10: Mount base.

11, 31: Protrusion.

12-17: Pattern.

20: Throughholes.

25: Metallic member.

30: Metallic plate.

40: Insulating layer.

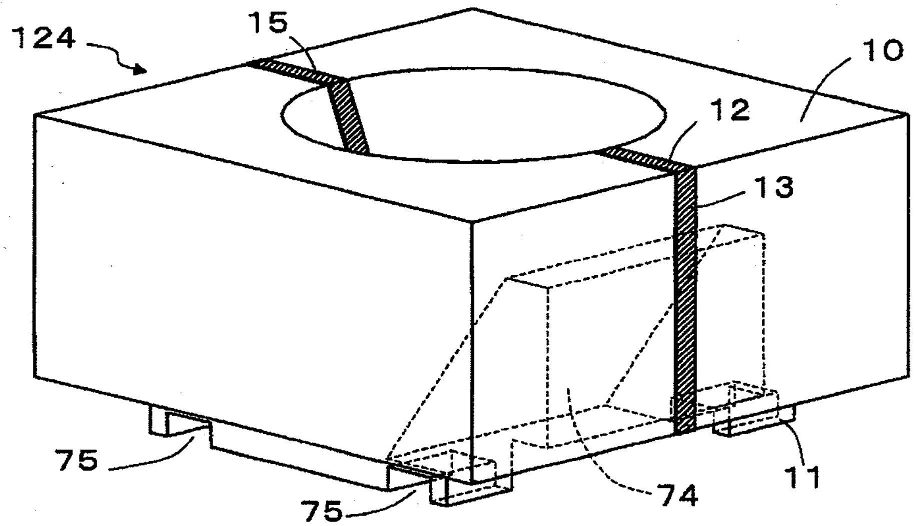
41: Metallization pattern.

63, 66, 69: Bonding agent.

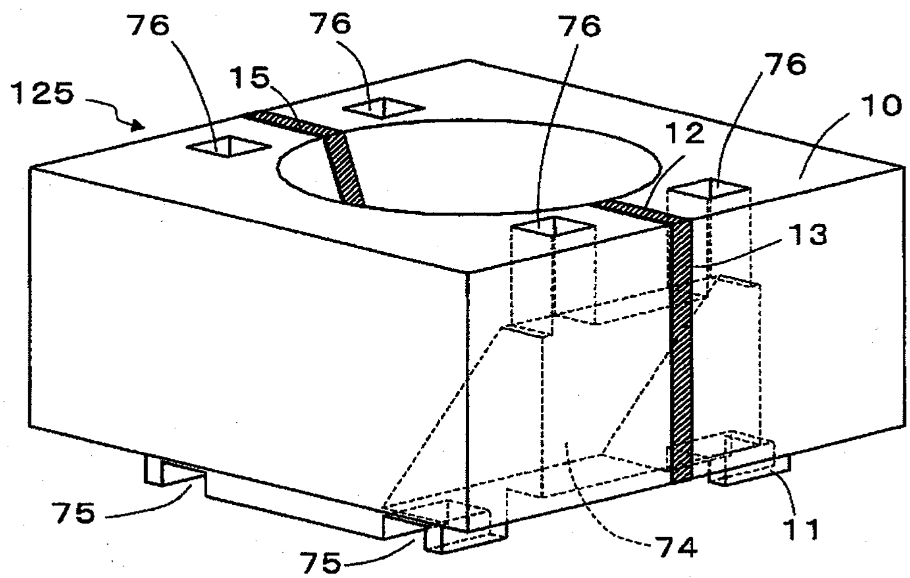
100-125: Submount.

200-216: Light-emitting device.

【図４２】 Fig. 42

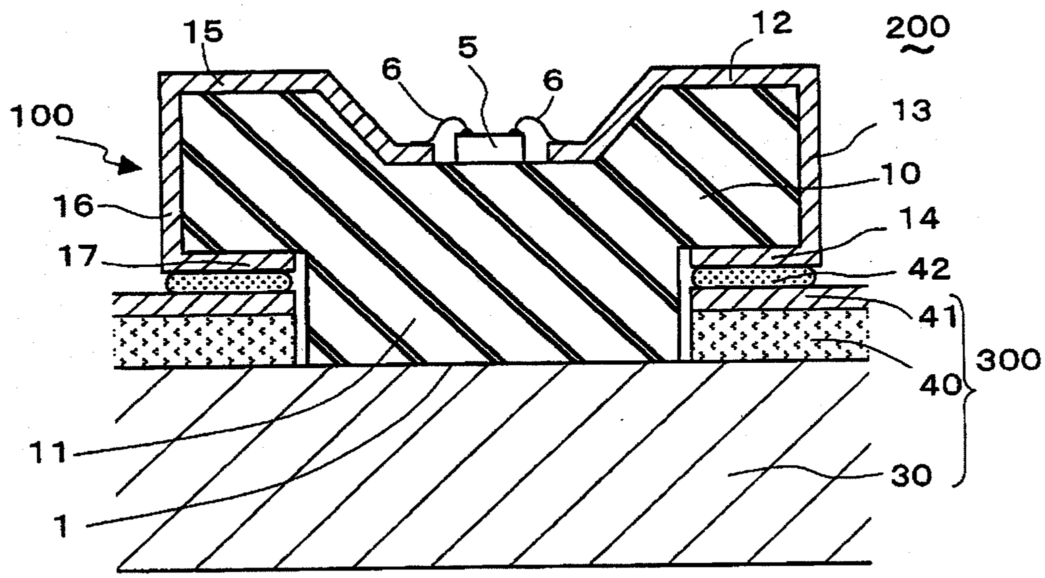


【図４３】 Fig. 43

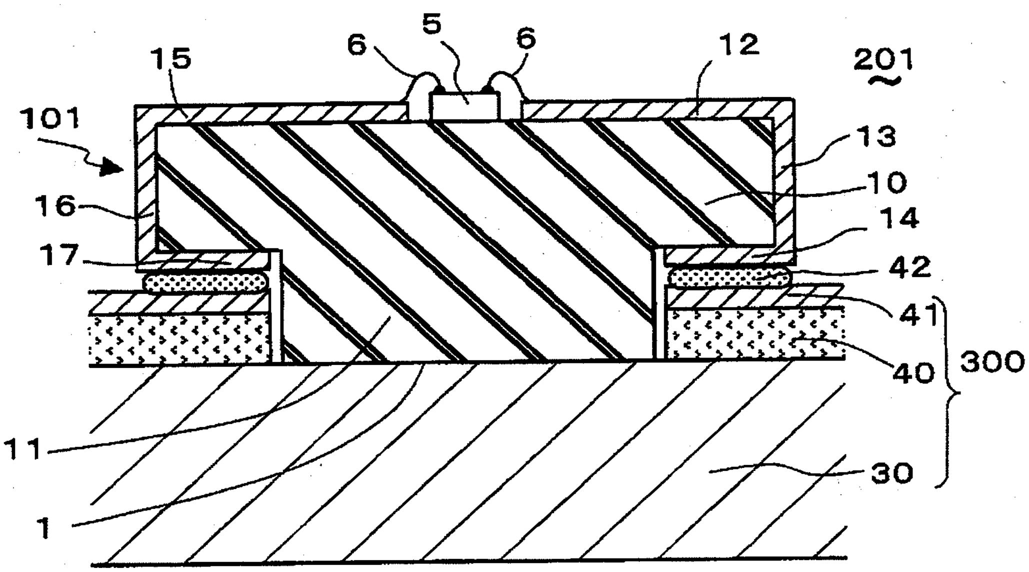


【書類名】図面　Document Name; Drawings

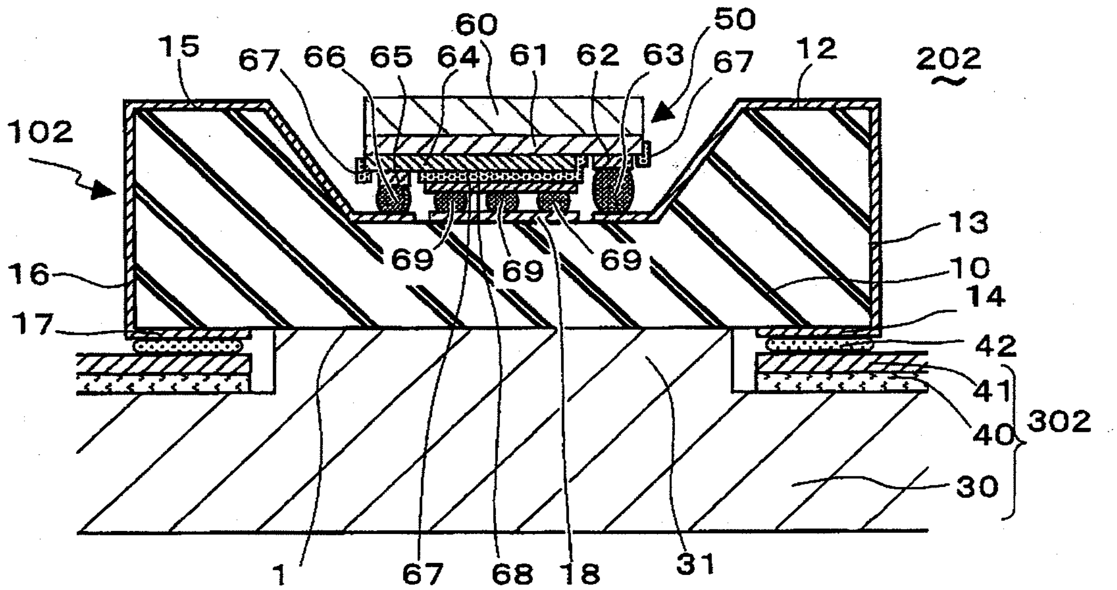
【図1】 Fig. 1



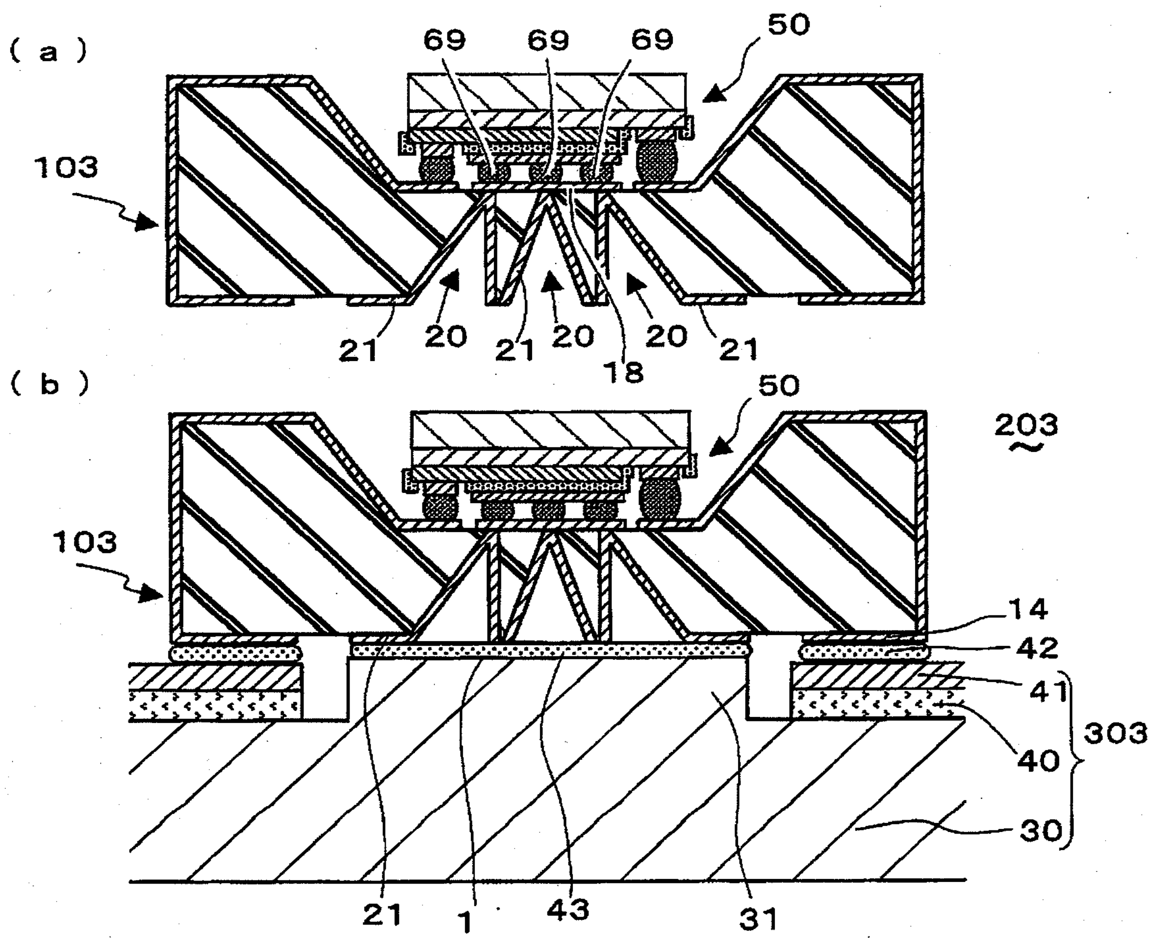
【図2】 Fig. 2



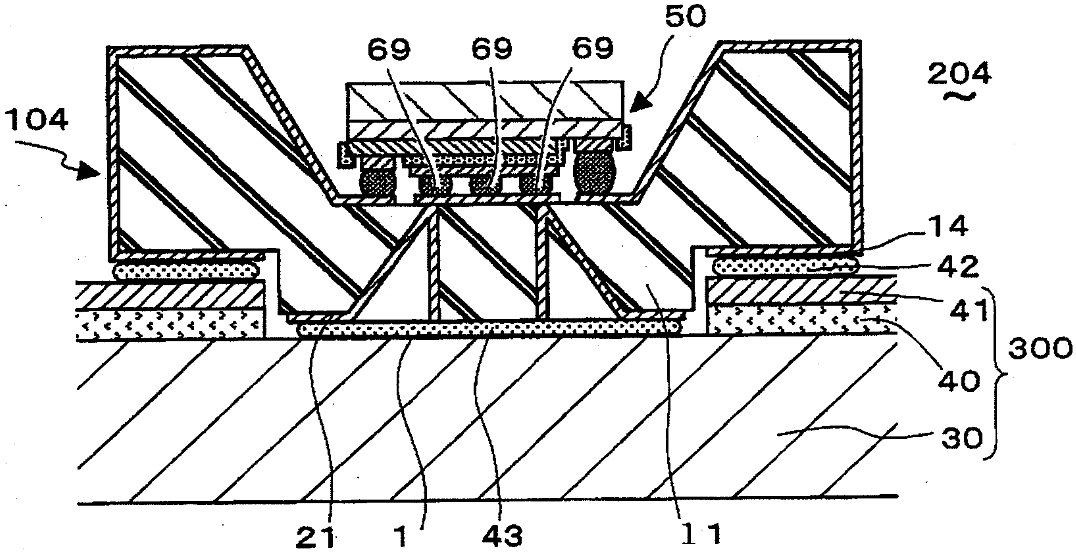
【図３】 Fig. 3



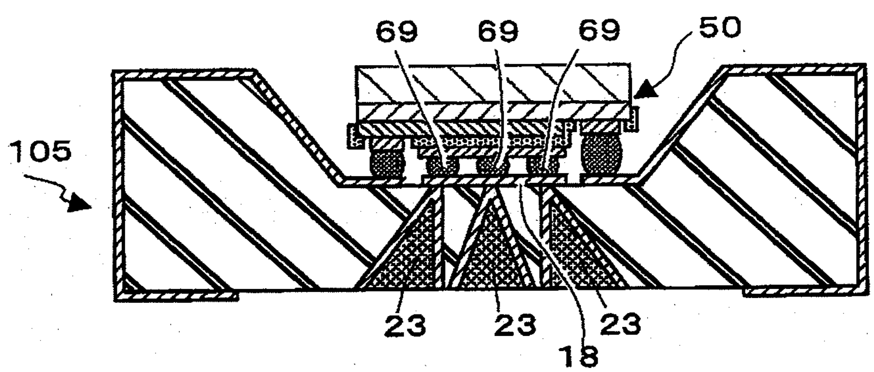
【図４】 Fig. 4



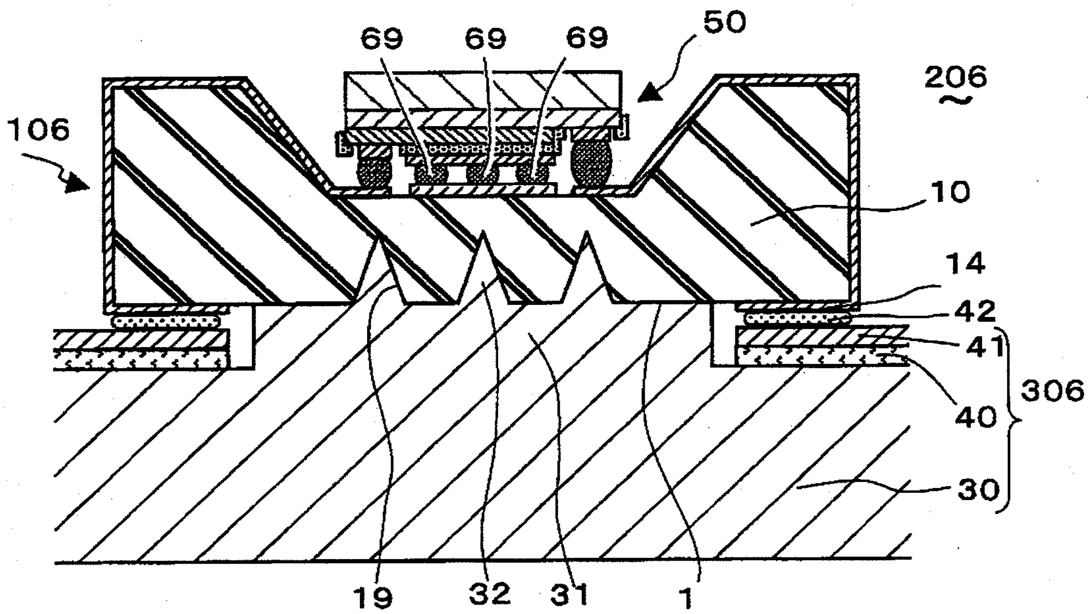
【図５】Fig. 5



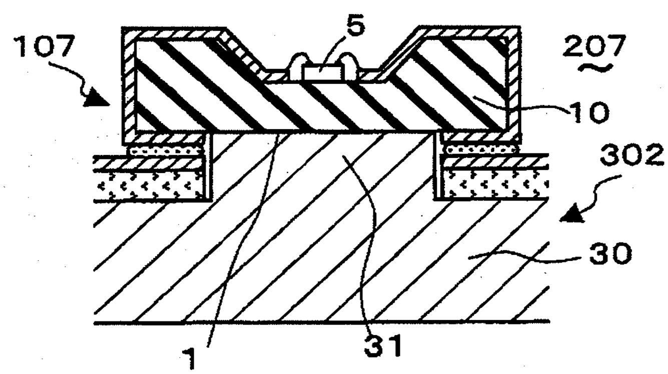
【図６】Fig. 6



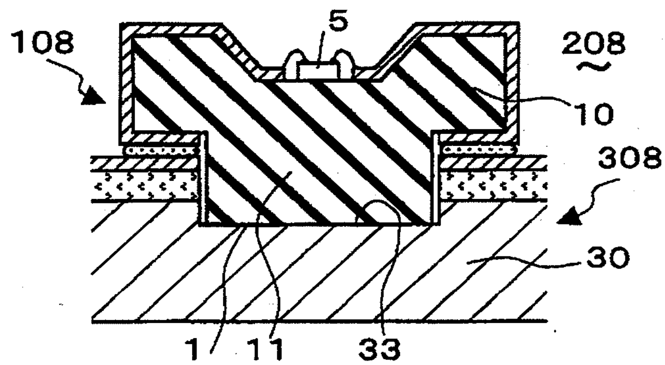
【図７】 Fig. 7



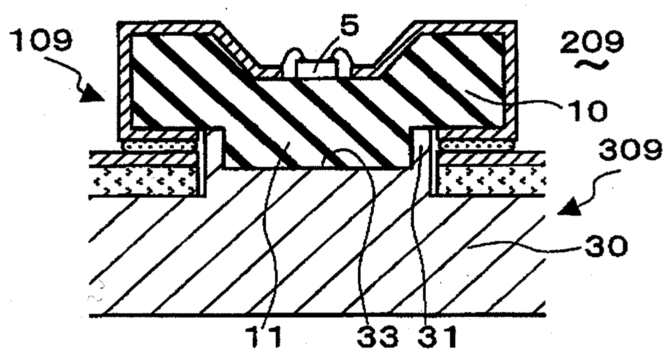
【図８】 Fig. 8



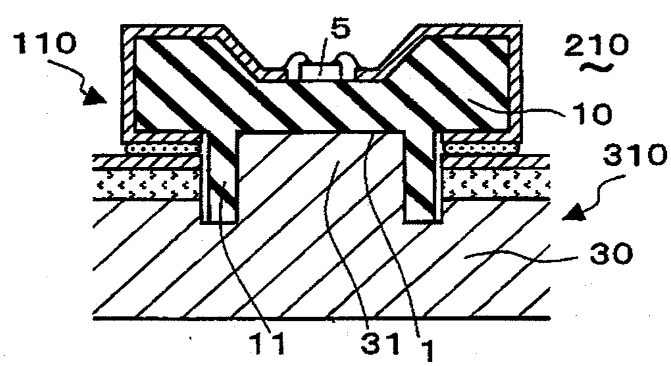
【図９】Fig. 9



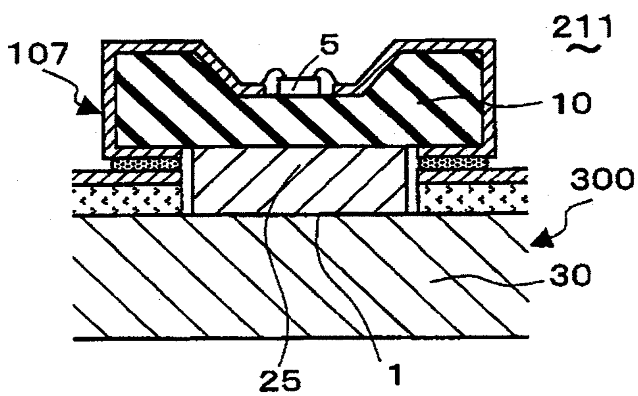
【図１０】Fig. 10



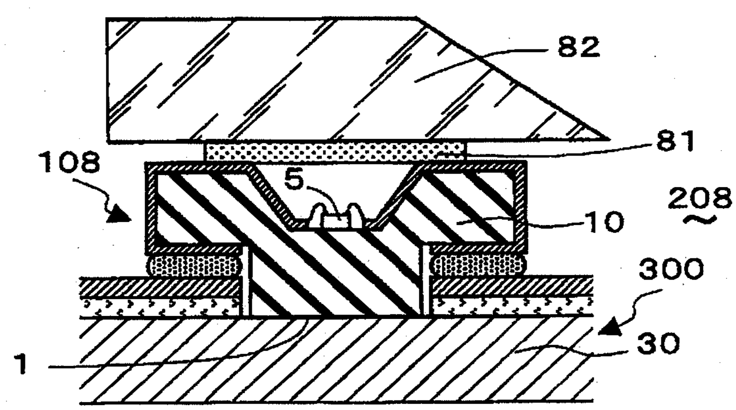
【図１１】Fig. 11



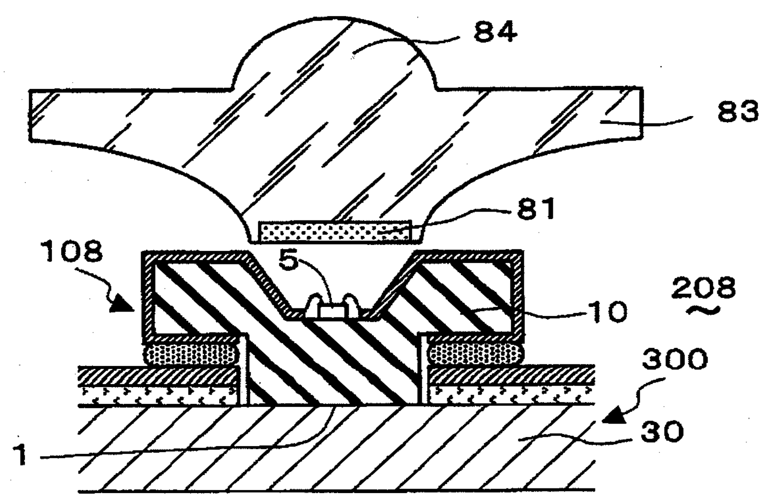
【図１２】Fig. 12



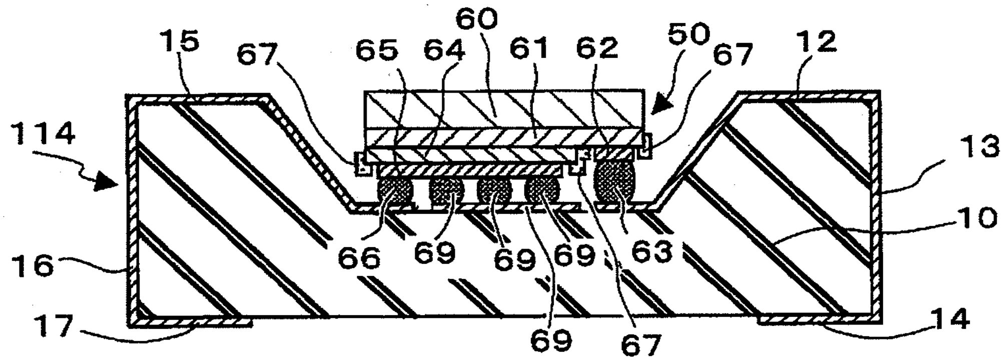
【図１３】Fig. 13



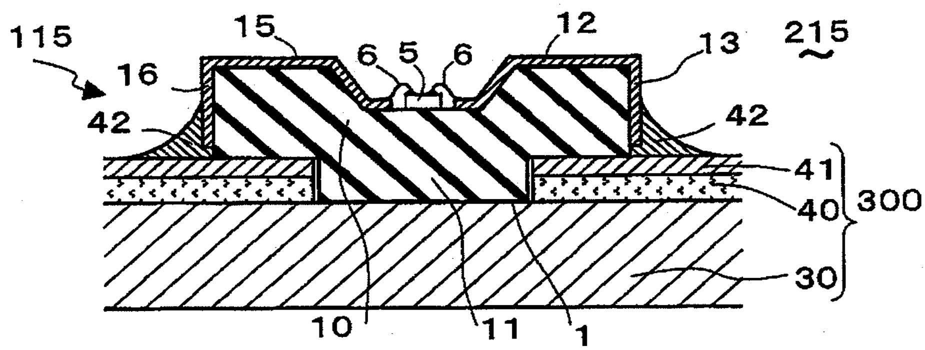
【図１４】Fig. 14



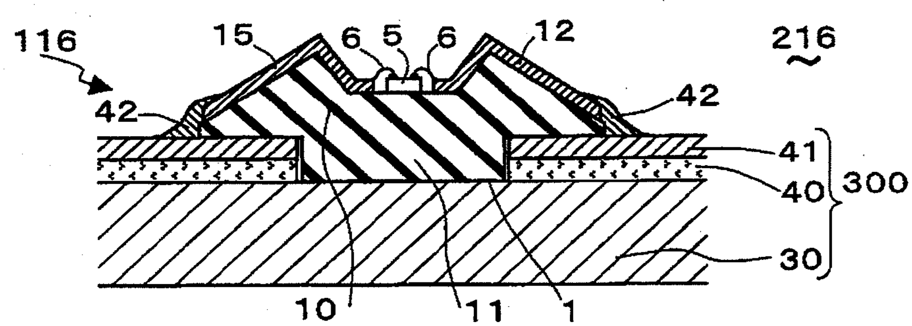
【図１５】Fig. 15



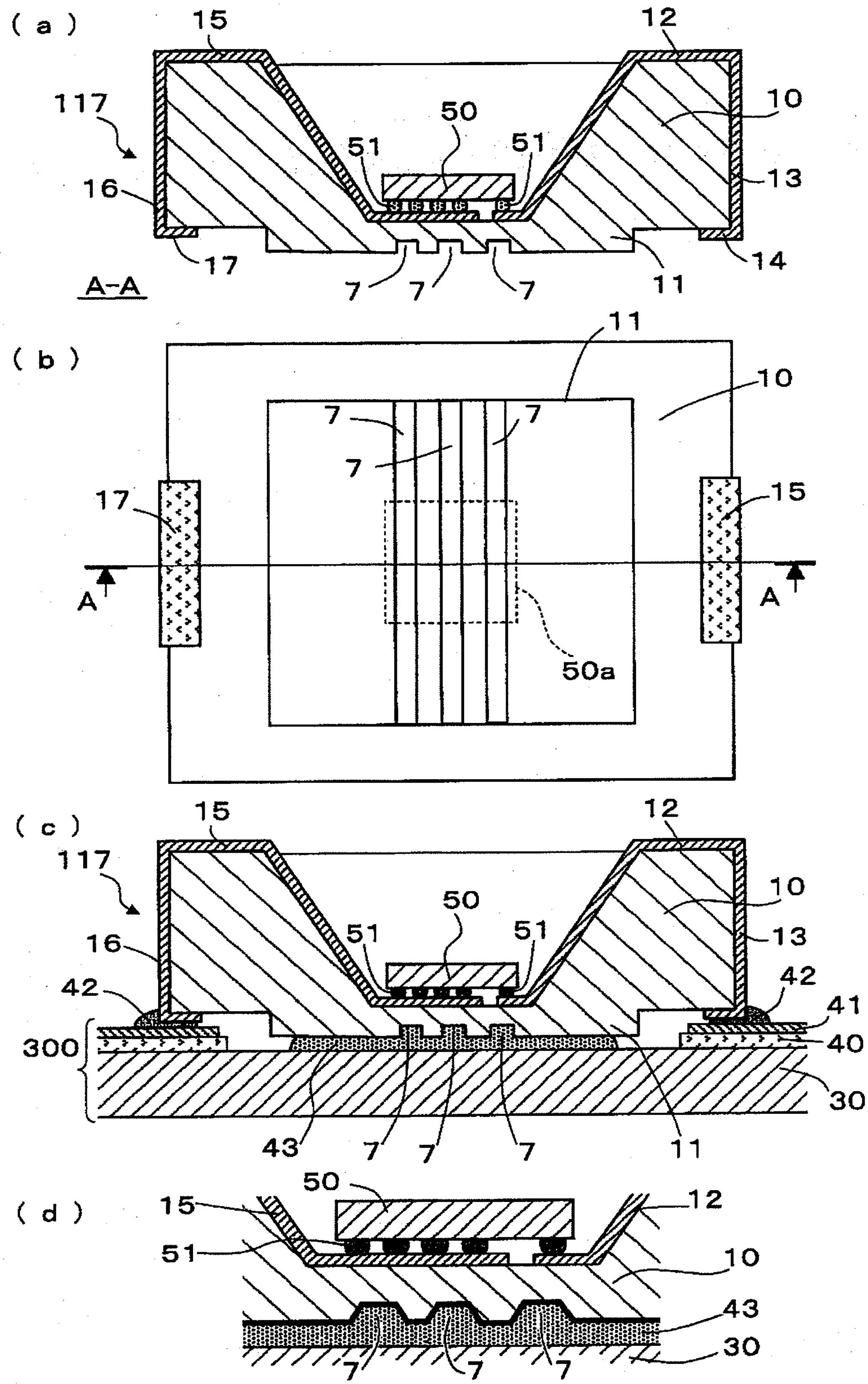
【図１６】Fig. 16



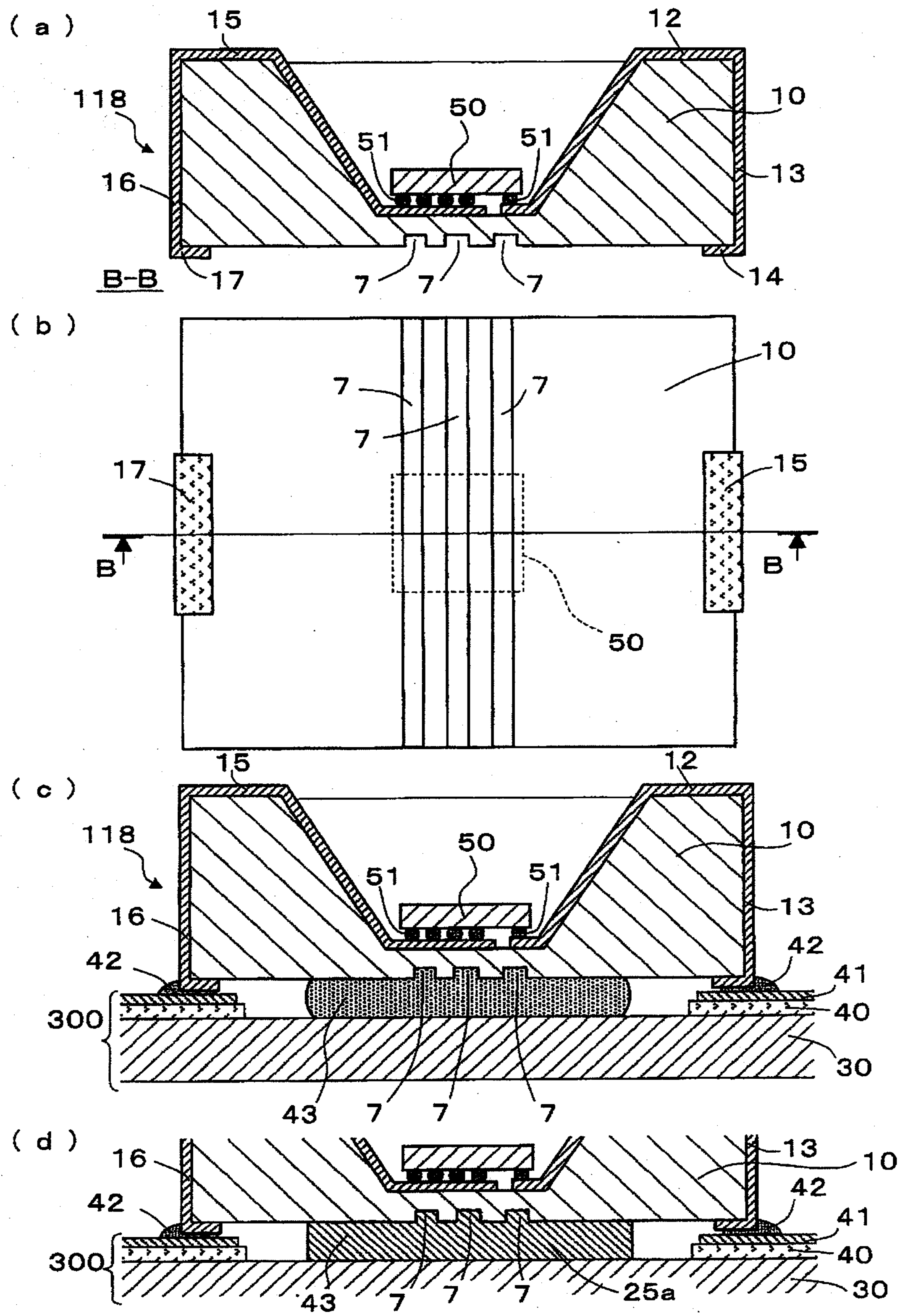
【図１７】Fig. 17



【図１８】 Fig. 18


(a)
15
12
117
50
10
51
51
13
16
17
14
A-A
7
7
7
11
(b)
11
10
7
7
7
17
15
A
A
50a
(c)
15
12
117
10
50
51
51
13
16
42
42
41
300
40
30
43
7
7
7
11
(d)
50
15
12
51
10
43
30
7
7
7

【図１９】Fig. 19



(a)
15
12
118
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16
13
B-B
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7
7
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14
(b)
10
7
7
7
17
15
B
B
50
(c)
15
12
118
10
50
51
51
16
13
42
42
41
300
40
30
43
7
7
7
(d)
16
13
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42
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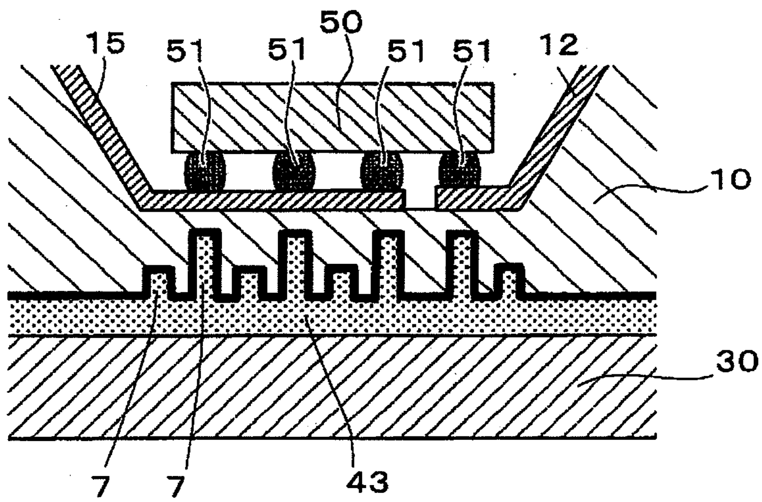
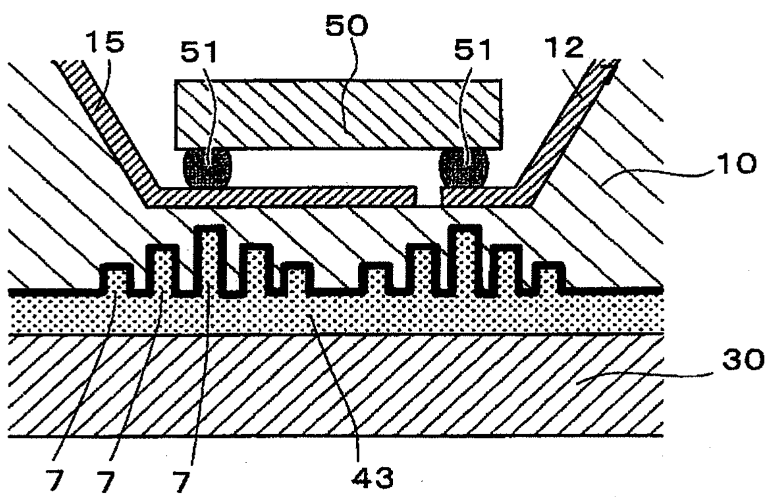
300
40
43
7
7
7
25a
30

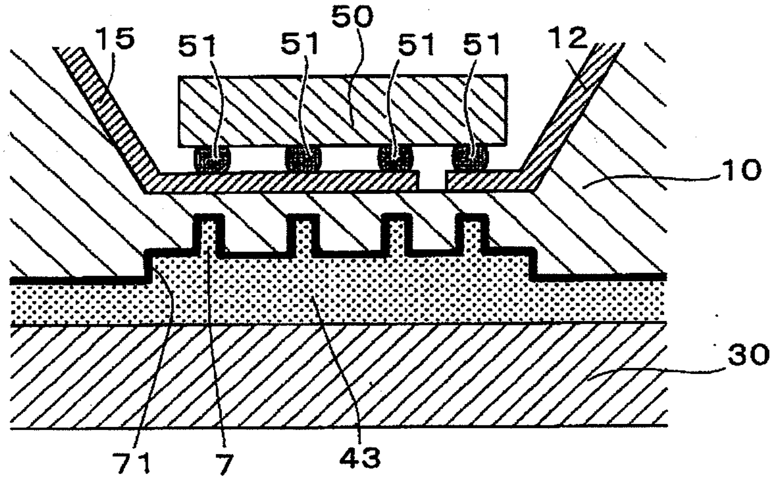
【図２０】Fig. 20



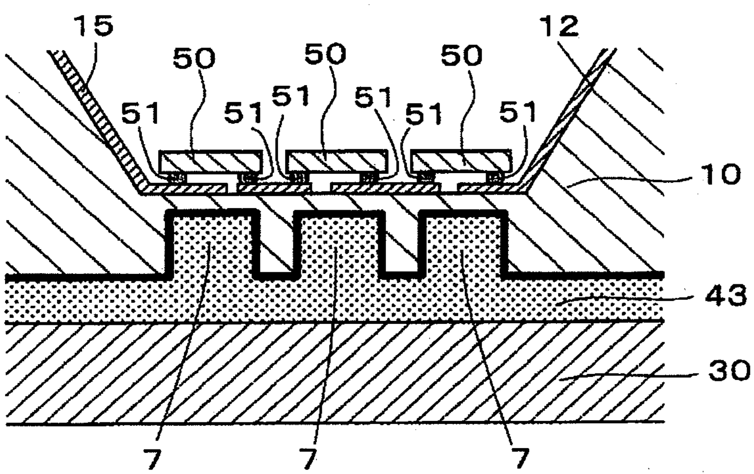
【図２１】Fig. 21



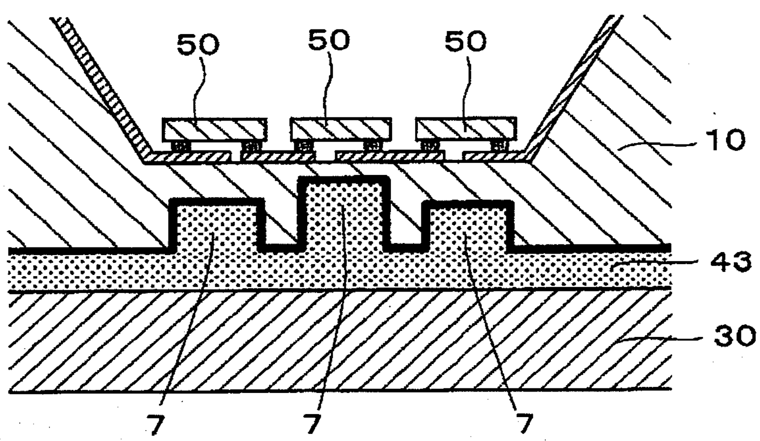
【図２２】Fig. 22



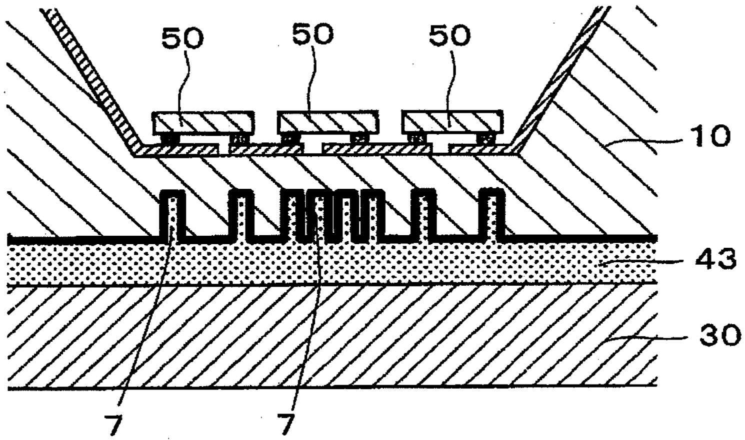
【図２３】Fig, 23



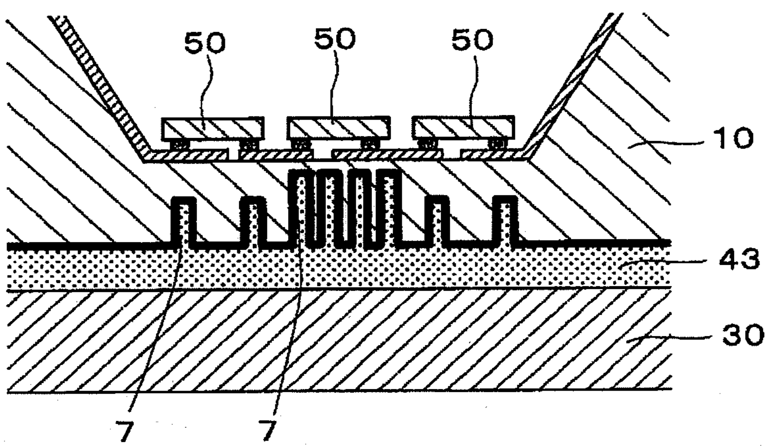
【図２４】Fig. 24



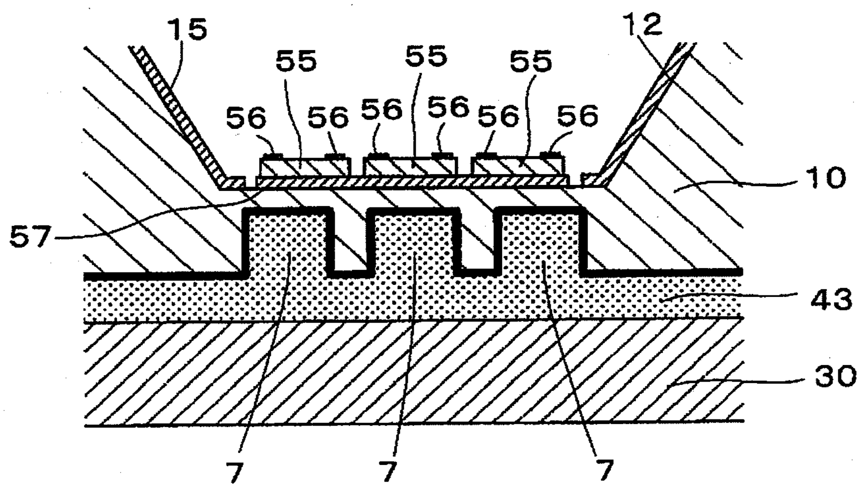
【図２５】Fig. 25



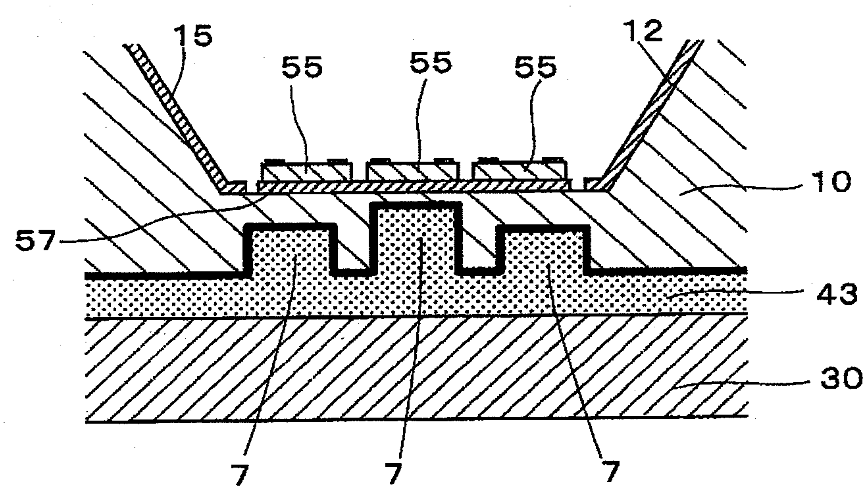
【図２６】Fig. 26



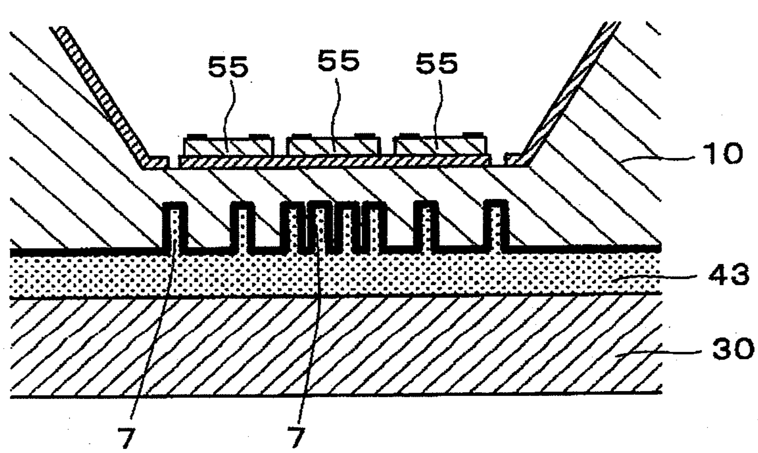
【図２７】Fig. 27



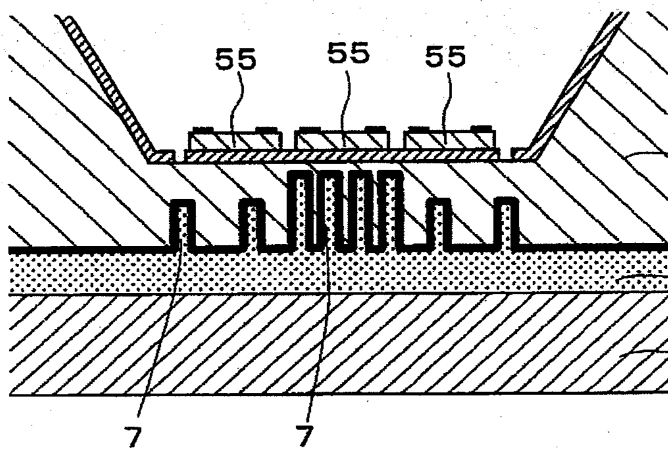
【図２８】Fig. 28



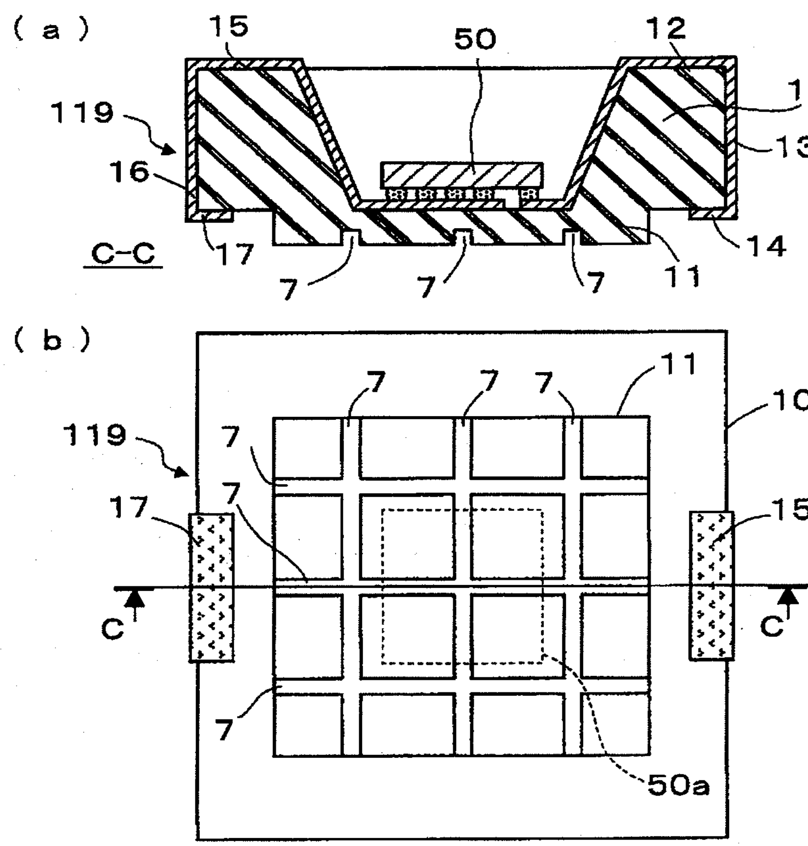
【図２９】Fig. 29



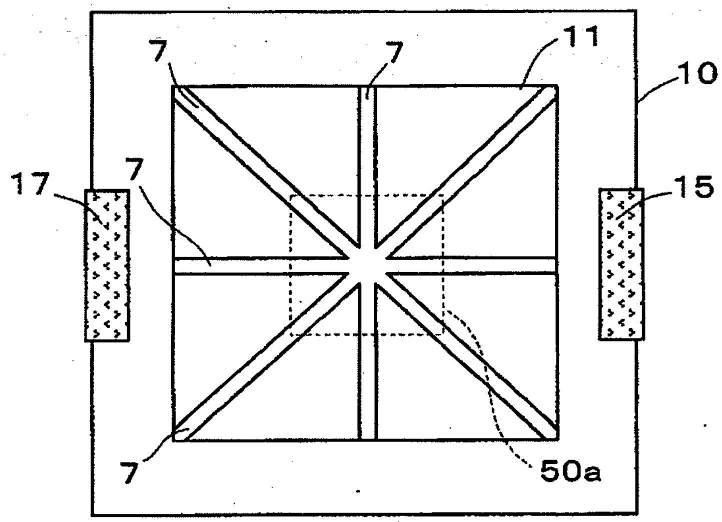
【図３０】Fig. 30



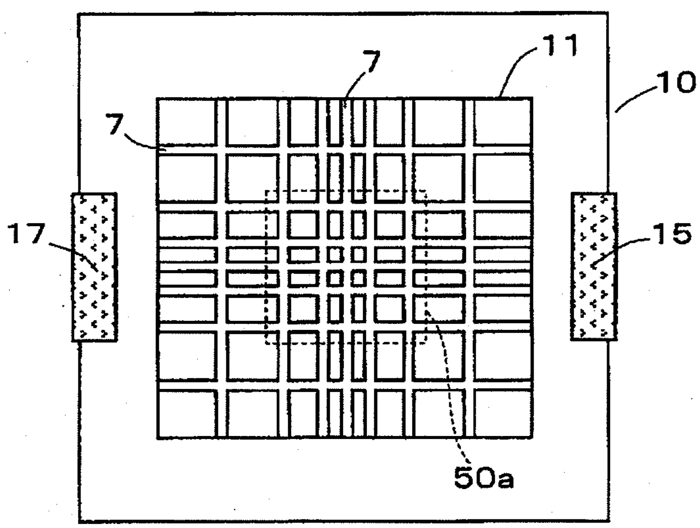
【図３１】Fig.31



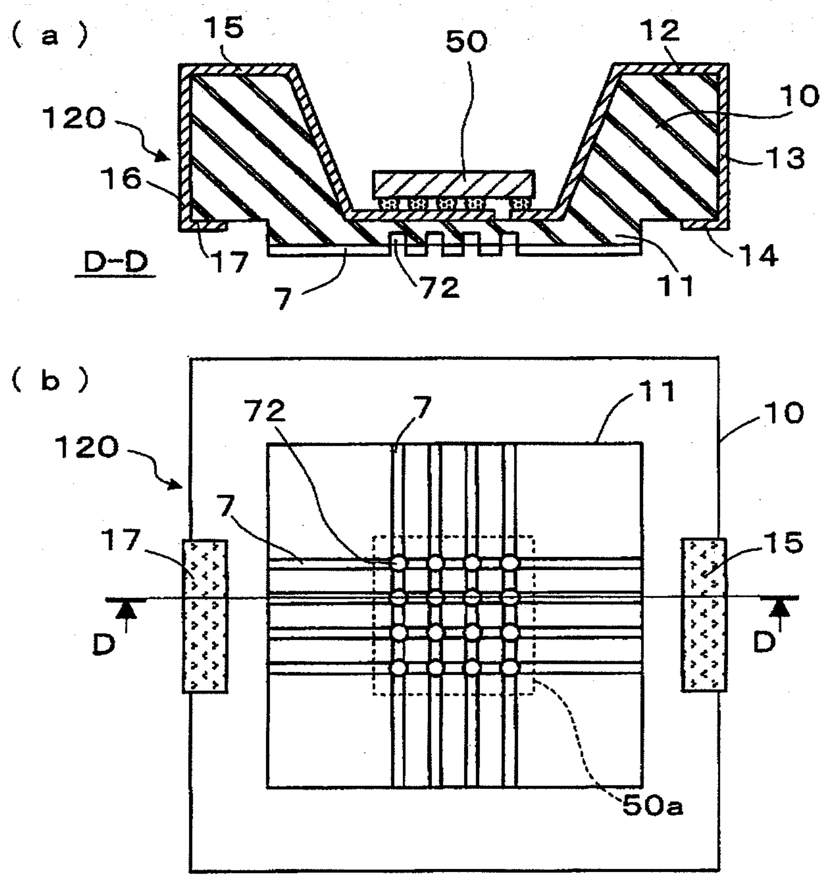
【図３２】 Fig. 32



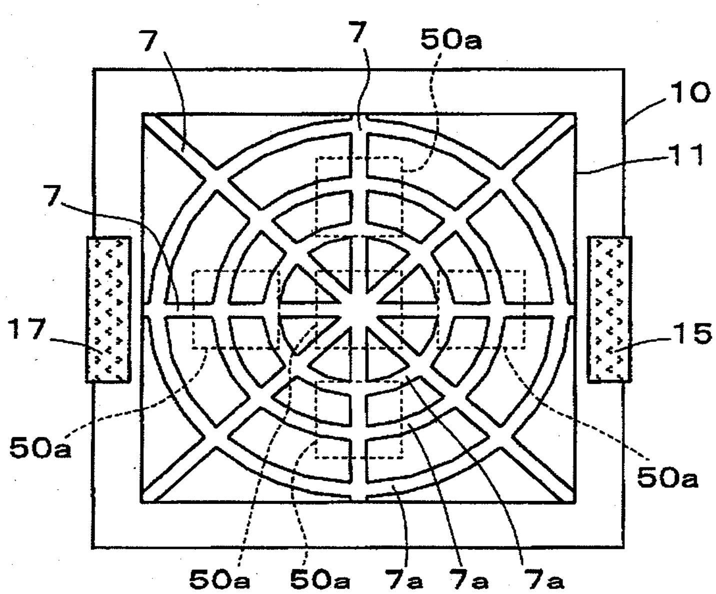
【図３３】 Fig. 33



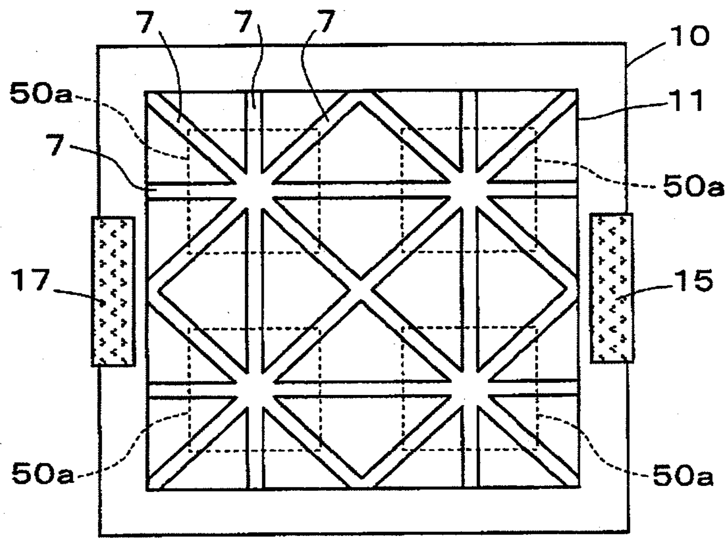
【図３４】 Fig. 34



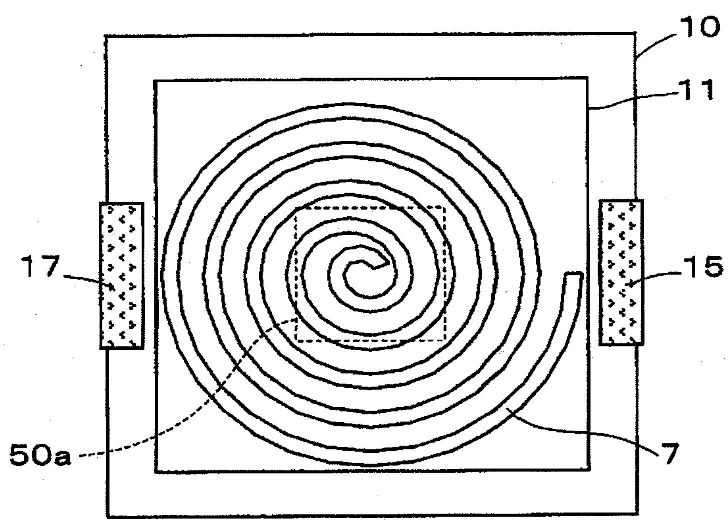
【図３５】 Fig. 35



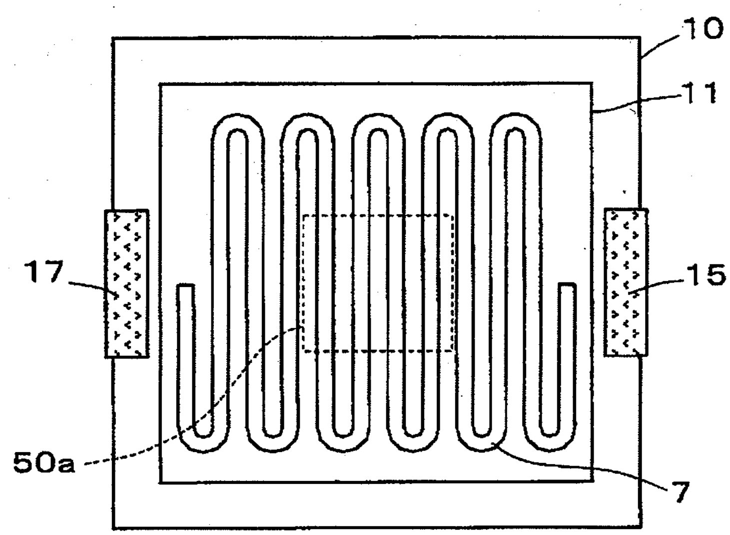
【図３６】Fig. 36



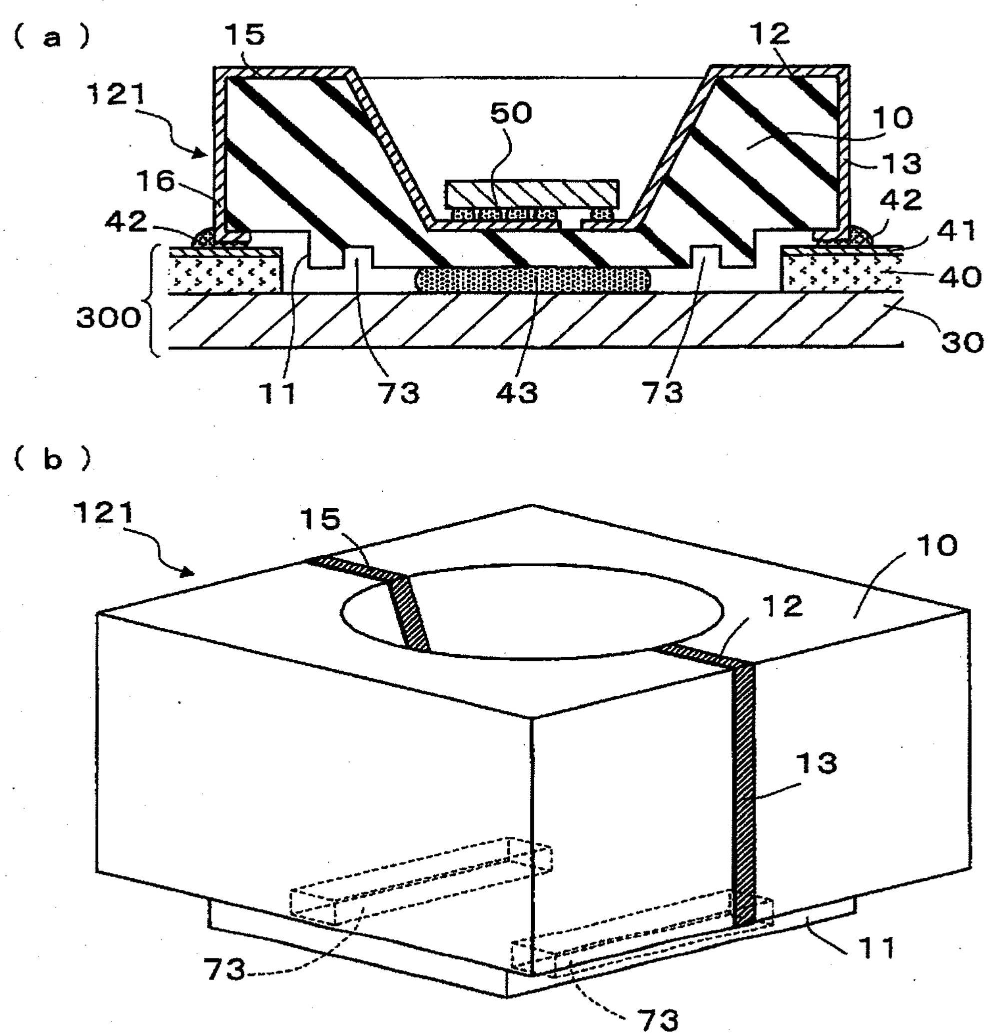
【図３７】Fig. 37



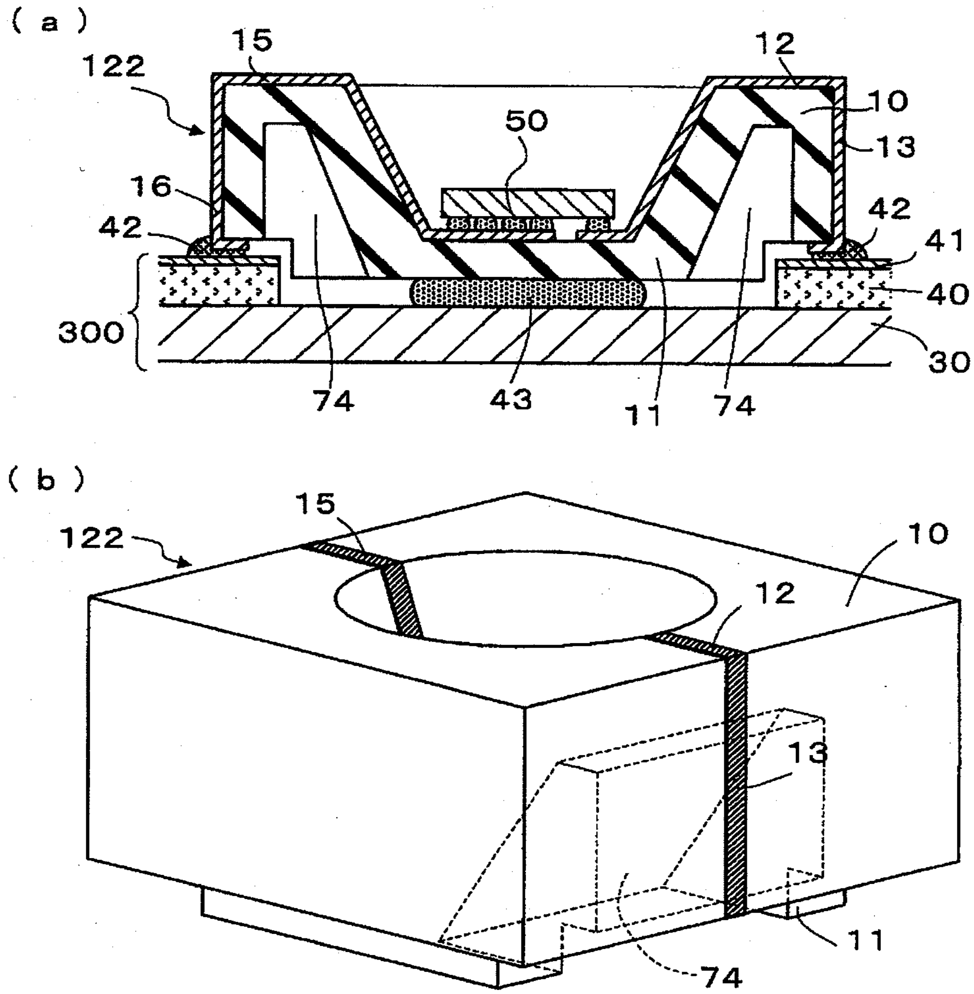
【図３８】 Fig. 38



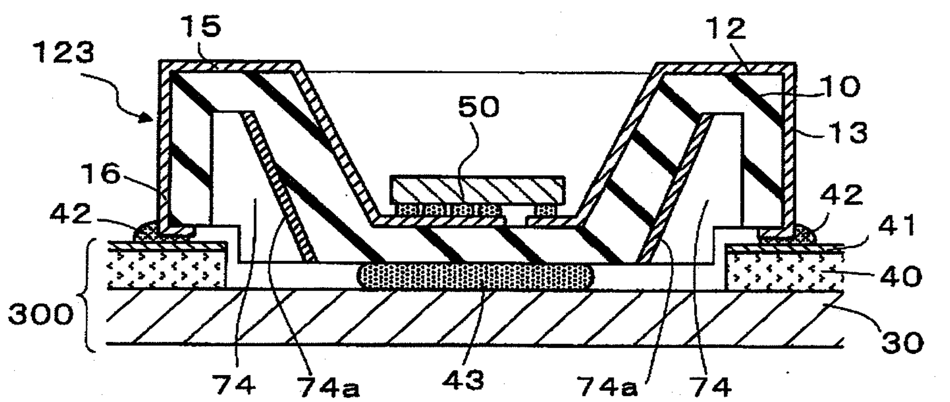
【図３９】 Fig. 39



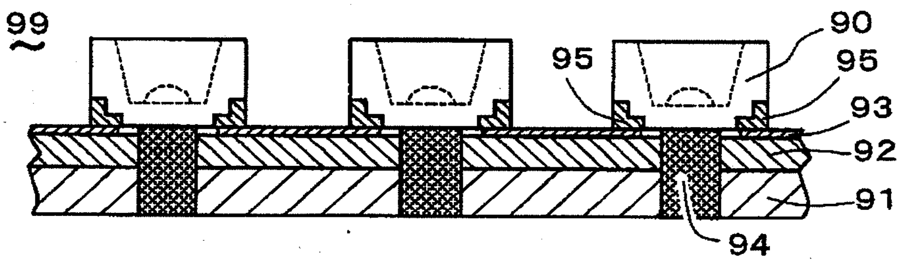
【図４０】Fig. 40



【図４１】Fig. 41



【図４４】 Fig. 44



ABSTRACT

[Problem] TO improve heat transfer in a light-emission device with LED chips with a simple structure.

[Solution] A light-emitting device 200 has a submount 100 and a plate 300 for heat transfer having a metallic plate 30. The submount 100 includes a mount base 10, at least one light-emitting diode chip 5 mounted thereon and electrically conducting lines 12-17 formed on the mount base. The submount 100 is mounted on the plate 300. The conducting lines 12-17 are connected electrically to the pattern 41 o the plate 300, and the mount base 10 makes thermal contact with the metallic plate 30 exposed in the plate, so that heat generated in the LED chips is transferred to the plate 300 and this improves the heat transfer simply.

[Representative drawing] Fig. 1

Applicant Record

Identification No.: 000005832

1. Date of Registration: August 30, 1990 (newly recorded)

   Address: 1048, Oaza-Kadoma, Kadoma-shi, OSAKA

   Name: Matsushita Electric Works, Ltd.